THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 49. Thursday, July 27, 1933. No. 884.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Telephone: Central 1895. Telegrams: CIRA.

The B.C.I.R.A. Scottish Laboratories are:—

Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 332*).

Forthcoming Event.

SEPTEMBER 18-21.

Institute of Metals:—Silver Jubilee Autumn Meeting in Birmingham.

Home-Produced Petrol.

The announcement recently made by the Prime Minister in the House of Commons that the Government had decided to give a preference of 4d. per gallon on home-produced motor spirit is of the greatest possible importance. As we have previously pointed out, the importation of the whole of our motor spirit, principally from the United States, is one of the biggest single factors in our adverse trade balance. The refining in this country certainly provides some work, both directly and to equipment makers, but nothing like as much as would come from a complete home supply. The scheme is welcome evidence that the extraction of petrol from coal is a commercial possibility, and it is understood that the cost of production on a large scale is just about the amount of the protection per gallon more than that of imported spirit.

It is stated that Imperial Chemical Industries will establish a plant costing seven millions at Billingham, to make thirty million gallons of petrol per annum, and using 350,000 tons of coal. This output represents one-fortieth of our annual consumption. It must not be thought that a monopoly is being set up. The Billingham petrol will be produced by the hydrogenation process, one of the most remarkable scientific developments of recent years, in which coal is converted to oil under very high pressure by means of hydrogen. A certain amount of petrol, however, can be obtained from the oils produced by means of the low-temperature carbonisation process, to which we have referred on several occasions.

Both these processes are likely to employ a large amount of plant made in the foundry, and we hope that some establishments will specialise on work of this character, and not allow it to become the subject of cut-throat competition like the heavier forms of common constructional work. Scientific study of the requirements and their fullest possible application is required.

We do not recall having seen any reference to the position of benzole, which is produced in comparatively small quantities—for example, in gas-works processes using a high-temperature carbonisation. It is now sold at a price similar to that of petrol, and there seems to be no reason to deprive it of the advantage of the rebate.

Whether the scheme will do much for the coal industry is open to doubt, as only a thousand miners extra will be employed, but fourteen thousand altogether will be absorbed on the scheme.

The New Labour Problem.

With the advent of better trading conditions, a number of problems are arising with the labour now being absorbed. This is of two kinds: those men who have reached manhood without having had any factory experience and those who have had a long period of enforced idleness. Of the second type it is general experience that their output is of a low order. For instance, several fettlers who, four years ago, could clean eight of a standard type of casting, could on return to work but fettle four, and after a week in harness worked up to five. Every sympathy must be extended to these men, whose worth has previously been proved, and moreover it does show that an infinite amount of patience has to be lavished on those who have never had the opportunity of earning their own living.

It has been noted that these new entrants to industrial life are particularly prone to minor accidents, and the accident-prevention methods employed by the various industrial organisations probably need overhauling, having these conditions well in mind. We have personally a poor opinion of the poster method of preventing accidents, and prefer that each new-comer should be provided with a rule book, wherein could usefully be incorporated a range of notions designed to minimise the accident hazard.

It is also asserted that a shortage of certain types of skilled men is being experienced, and this factor will be progressively serious as time passes. All these new conditions will throw more work and anxiety upon the managers and foremen, and it appears to us that for some years to come a more practical training than would normally be the case should be given to engineering and metallurgical students. Discussing this matter over the week-end with Professor Andrew, of Sheffield University, he assured us that it was his ideal that the students to be trained in his proposed foundry department would be fitted to take their place in the foundries and be of practical value to the management immediately after graduation. This, apart from internal tutorial methods, will reasonably be assured, as a considerable portion of the student's time will be spent in practical work in commercial foundries

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Me Fecit 1569.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The illustration shows an example, in an excellent state of preservation, of early bell-founding. In view of its age and condition, a few particulars of the bell may be of interest to readers of THE FOUNDRY TRADE JOURNAL.

Cast in bell-metal, the specimen measures 4½ in. from base to top, its greatest width being 3 in. It weighs 1 lb. 2½ oz. Two "medallions" embellish its sides, one of which shows what may be a winged mastiff, while the other depicts a venerable personage, seated, holding in his right hand a shield charged with a species of rampant quadruped. Another remarkable

BELL CAST IN 1569 BY E. H-MONY.

animal fawns upon his left knee. Around the skirt of the bell the maker has cast his name —E. H-Mony, and adds, "Me fecit anno 1569."

The bell, which gives a high clear note when rung, was found in an old Dorsetshire house after a disastrous fire. I have been unable to ascertain who E. H-Mony was or where he cast his bells. Perhaps some of your readers whose hobby is campanology can offer some information. —Yours, etc.,

GLYNNE WILLIAMS.

Lyme Regis,
July 25, 1933.

The Wilkinson Brothers.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—By an oversight I have only just seen the Editorial in your issue of July 6. You state that in an article written by M. Moutard in "La Fonte," statements in my Paper on the "History of Ironfounding in the Midlands" are contradicted. I venture to suggest that your presumption that the Wilkinson referred to by M. Moutard was *John* Wilkinson is incorrect and that it was William Wilkinson who was employed by the French Government in the year 1780. This is confirmed by Dickinson on "John Wilkinson," or more ready reference perhaps could be made to Ashton's "Iron and Steel in the Industrial Revolution." On page 46 there is a letter from the French Ambassador to the British Foreign Secretary dated December, 1775, requesting permission from the British Government "to import Canon from John Wilkinson." On page 54 Ashton states: "During the 'seventies the new processes were carried to France by *William* Wilkinson, who directed the construction and working of blast furnaces at Le Creusot between 1778 and 1781." Further, on page 66: "At the time when Boulton and Watt began to erect steam engines commercially he (John Wilkinson) was engaged in negotiations with the brothers Perrier, who were engineers for the Paris Waterworks, and through his brother *William*, who spent many years in France, he obtained from them an order for some 40 miles of cast-iron piping."

If further proof be necessary of John Wilkinson's residence in the Midlands from 1748 until the time of his death, ample evidence is available. See Dickinson on "John Wilkinson," Aris's "Birmingham Gazette," Hackwood's "Olden Wednesbury," etc.—Yours, etc.,

D. H. WOOD.
The Constructional Engineering Company, Limited,
Titan Works, Charles Henry Street,
Birmingham,
July 20, 1933.

[We thank Mr. Wood for his interesting communication. One often hears reference to Wilkinson at Le Creusot and Decazeville, and we suppose that if the French refer to "Wilkinson" it is *William* and if the British *John*.—EDITOR.]

Catalogues Received.

Heating Boilers.—When we received an advance catalogue issued by Messrs. Crane, Limited, of 45-51, Leman Street, London, E.1, we were, personally, particularly interested, as for many years we have undertaken a personal supervision over our own boiler for central heating. This catalogue claims 17 points of improvement, and we were impressed with claims numbered 5 and 6. We find very little trouble with soot, unless the gardener or maid uses the installation as an incinerator.

The boiler illustrated and described is known as the "Whitehall" model. One of the features is the use of a relatively shallow fire, with secondary air admission over the fire to burn any CO that may be produced. Charging is effected at the side and not from the top. This permits the installation of tubes above the fire. Normally, for efficiency in combustion, rate of burning is of paramount importance, as the quicker this takes place the more insignificant become radiation losses. Yet with domestic furnaces there is a demand for reasonable efficiency from slow combustion, lasting all night, from a relatively small mass of fuel. With this system, described in this 24-page, well-illustrated brochure, a nice balance between efficiency at "full air" and "shut down" should be attained. The only doubt we have is the cleaning of the corners at the side of the charging door.

A claim, not inserted, is the obvious freedom from "scaffolding," which occurs with circular boilers if the coke used be of too large a type. The design readily lends itself to the use of oil fuel, and the larger sizes are well suited for the heating of offices and factories.

Aluminium in the Gas Industry.—In an excellently-produced pamphlet, the British Aluminium Company, Limited, of Adelaide House, King William Street, London, E.C.4, have outlined the potentialities of aluminium in the gas industry. The information given is germane to the actual manufacture of gas, its storage and its consuming apparatus. The matter is well illustrated, and those of our readers who manufacture gas fires and cookers and other gas-burning contrivances would be well advised to secure a copy for themselves.

Random Shots.

I lunched this morning in a nasty little Soho restaurant. It is a curious fact that while everybody who has ever been to London knows of a delightful little restaurant in Soho where the food is delicious, the wine momentous, and both cheap, nobody seems to know of a restaurant that is correspondingly nasty—except me. I lunched in one this morning. It was perhaps the hottest morning of the year, and, remember, there have been many hot mornings this year. The restaurant was sticky, and the air composed of equal parts of spaghetti, chianti, nitrogen, oxygen and flies. There was no electric fan. The bulbous old brigand who combined the offices of proprietor and waiter was this morning more of a proprietor than a waiter. He only waited on me when I shouted loud and long; the rest of the time he was sunk in an uneasy coma, dreaming perhaps of the bay of Naples and the happy day when he was admitted into the Neapolitan branch of the Society of Political Assassins. In fact, I did most of the waiting, and long and weary waiting it was.

* * *

As I waited, I tortured myself, after the fashion of an Indian fakir, with thoughts of ideal places for lunch on such a broiling morning, and it occurred to me (I am rather prone to these flashes of inspiration) that my readers could probably produce equally good lists. I would be pleased to receive contributions from some of the correspondents who so often rally to my aid on these occasions. Here is my list.

* * *

5,000 ft. up in an aeroplane.
5,000 ft. down in a submarine.
In a large cave on the Atlantic coast of Cornwall, with running water laid on.
In the bar parlour of the "Pig and Whistle" in Devonshire, with no oldest inhabitant in sight.
On an iceberg in the Arctic Circle.
On the uttermost peak of Mount Everest.
In the freezing-room of an ice-cream works.
In a hammock in the old-world garden of Chorlton-cum-Hardy Rectory.
With Professor Piccard in the stratosphere.
Demonstrating bathing costumes in Siberia.

* * *

Following my suggestion as to the need for an official album of informal snapshots taken at the Annual Convention and similar gatherings, I have received the following communication from one who signs himself "Multi-Convener":—

* * *

"Now that the capacity of the General Office in Manchester has been augmented, it is surely the most appropriate place to file unofficial as well as official photographs of the Institute and its members in the possession of the General Secretary, himself an ardent photographer. You would probably notice that the Zurich meeting of the Institute of Metals, held two years ago, was commemorated by an album of photographs enlarged to be uniform at post-card size, and these, as intimated in the December, 1931, Journal of that Institute, were to be available for inspection in the Library during office hours. No doubt an appeal on these lines, giving instructions that the photographs must be explicit in regard to place, date and occasion, with a list of members shown where possible, would be well received, and post-card filing is one of the easiest to accomplish."

* * *

I think we now ought to have the views of the General Secretary on this question.

MARKSMAN.

Works of the North British Steel Foundry, Limited.

VISIT BY THE INSTITUTION OF MINING ENGINEERS.

The North British Steel Foundry, Limited, was founded in 1907. The works are situated adjacent to Bathgate Upper Station, on the London & North Eastern Railway, about 18 miles from Edinburgh and 24 miles from Glasgow. They are equipped with a thoroughly up-to-date plant for the production of steel castings up to 5 tons, finished weight, for every branch of engineering. In addition, there is a well-equipped machine shop, laid out for the speedy production of finished wheels and axles, motor and steam-vehicle road wheels, machine-cut gearing, tramway tyres and brake shoes, locomotive-wheel centres, colliery haulages, etc. Further, Stevens & Sons, railway-signal manufacturers, late of New City Road, Glasgow, are now incorporated in the North British Steel Foundry, Limited.

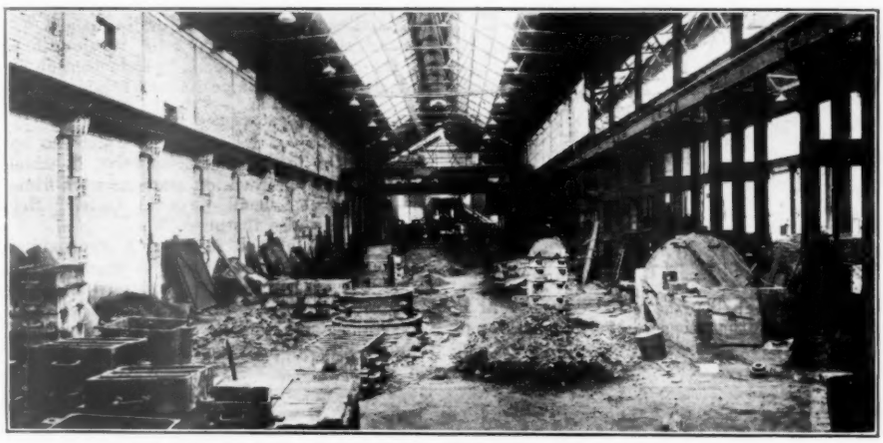

FIG. 1.—VIEW OF DRY-SAND FOUNDRY.

Works Lay-out.

As will be seen from our plan (Fig. 2), the works have been laid out to ensure a complete run through from the raw material to the finished production. Whilst careful consideration has been given to future requirements, the buildings are so disposed that extensions may be made to any section without interfering with the general continuity of the works. The works are circled by a double line of railway track, and lines of track also extend at right angles along the end of the shops.

Raw material of a light nature is discharged direct from the wagons into a series of brick-built bins, which are ranged parallel with the sidings. From these bins the material is hand-trammed to the stocking ground at the cupola. Pig-iron and other heavy material is discharged from the wagons to the stocking ground.

The Foundry.

The foundry is covered by two main bays, each of considerable dimensions. No. 1 bay, devoted to the production of heavy castings, is served by two 10-ton and one 5-ton overhead cranes, whilst at the top end of this bay are installed the cupola and Tropenas converters. No. 2 bay is devoted to the production of the lighter castings and also houses the stock converter, which is served by a 15-ton overhead crane.

There is a Whittaker gear moulding-machine, but with this exception, all moulds are hand made. It will be understood that most of the work is of a special nature, and in the case of repetition work, the hand making of the moulds is excellent training for the apprentices. An annexe to the main foundry is laid out for core making and wheel moulding. The whole of the cores are made with a special oil sand. The two core-drying stoves are coke fired. An overhead runway serves for the transport of the heavy cores from the shop to the foundry.

Melting Plant.

The melting plant consists of a cupola operating on the Poumay system, with a melting capacity of 5 tons per hr., working in conjunction with three Tropenas converters, each of 25-cwt. capacity, and a stock oil-fired converter of 2-ton capacity. The material is transported from the stocking ground to the charging platform of the cupola by a 2-ton Arrol crane; the cupola is hand charged. The metal from the cupola for the Tropenas converters is desulphurised by means of soda ash. This reduces the sulphur content considerably and has the further effect of cleaning the material. Ferro-alloy additions are preheated, where necessary, by means of four crucible furnaces. Metal for heavy castings is teemed from stopper ladles; and for the light, green-sand castings is poured from a kettle-spout ladle and carrying shanks.

The stock converter, which is, of course, a unit complete in itself, is charged with cold hematite and steel scrap, the converter being preheated. Crude oil is used for melting, and the charge when melted is converted by blowing in a manner similar to the Tropenas plant.

Blowing and Sand Plant.

The cupola is served by a Sirocco fan, which is driven by a 50-h.p. Bruce-Peebles motor; this blowing unit is installed in the power house. Blast for the Tropenas converters is supplied by two Roots blowers, which are each driven by a 50-h.p. motor, all of which are housed in a separate building. In a further building, adjacent to the unit, is a Roots blower driven by a 100-h.p. motor, which supplies blast for the stock converter.

The sand used consists of four main types; sand for heavy dry-sand castings, medium-dry sand castings, green-sand castings and for cores. These sands are mixed and prepared in a No. 2 Simpson intensive mixer, supplied by Messrs. August's Limited, of Halifax. The unit comprises bucket loader, mixer and discharge aerator. A Pneulec Royer is used for the preparation and conditioning of backing sand. This unit is fully portable and serves all points of the foundry.

Fettling.

The moulds are knocked out in No. 1 bay at a point in direct communication with the fettling shop, which, with the annealing plant, occupies a complete bay. The fettling-shop equipment comprises a full range of chipping hammers, pneumatic grinders, oxy-acetylene plant for cutting off risers, and 12 Dickinson lathes for

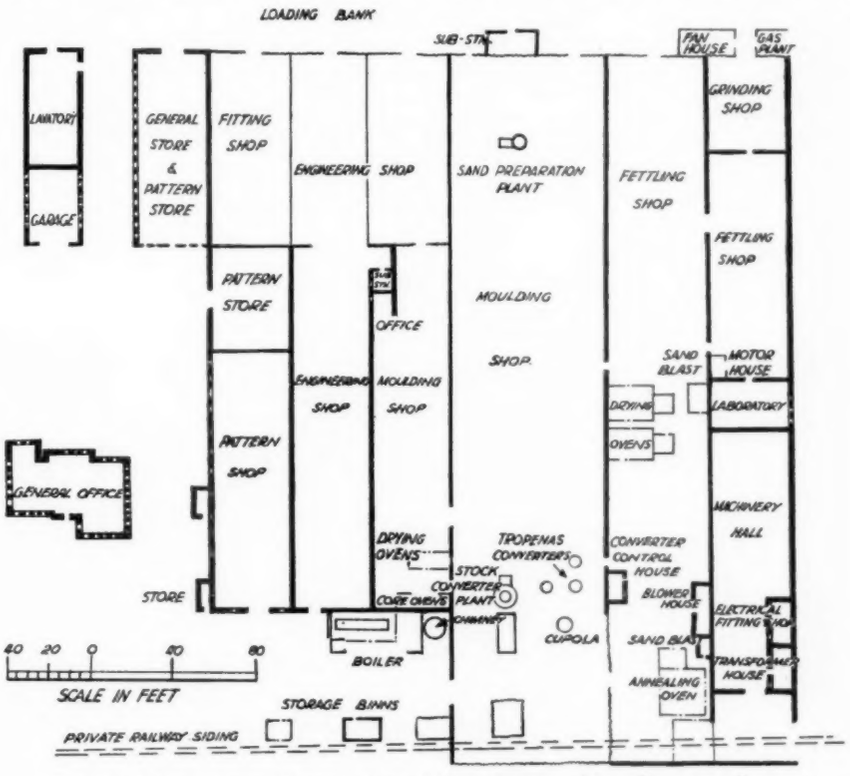

FIG. 2.—PLAN OF THE WORKS OF THE NORTH BRITISH STEEL FOUNDRY, LIMITED.

turning off risers. There are also one single- and one double-room Tilghman's sand-blast plants. Installed at the top end of the bay is a Stein & Atkinson bogie-type annealing furnace,

Fig. 3.—Portion of Green-Sand Foundry.

fitted with "Hagen" patent-type stokers. Pyrometers and recording instruments are systematically used. Grinding is done in a shop walled off from the main building, the equipment includes 20 grinding heads, and a very efficient dust-collecting system, by Howden, is in operation.

Power House.

In the power house are installed two motor compressors by Tilghman's Sand Blast Company, Limited, which supply blast to the single- and double-room plants. These compressors are fitted with Igranic distant control, which places the control of the blast in the hands of the sand-blast plant operator. The pipe lines for the pneumatic tools are supplied with pressure by two Belliss & Morcom motor-driven sets, one of which acts as a standby. The supply of current for the variable-speed motors throughout the works is met by two Bruce Peebles rotary converters, 6,000 volts a.c. to 440 volts d.c. As previously stated, the fan for the cupola is installed in this house. The power house is supplied with filtered air by means of a motor-driven fan delivering into a main, with down-coming ducts, extending for the full length of the house.

Machine and Patternshops, etc.

The machine shop is a well-lighted building covered by four bays. The equipment is essentially that of the up-to-date machine shop. Mention, however, may be made of three Sunderland gear planers, four Bullards vertical boring and facing mills, five Pearn-Richards & Kearns boring and facing machines, a battery of six Asquith radial drills, whilst amongst the lathes is one capable of taking work up to 16 ft. in diameter.

The patternshop has the usual complement of machines. For the storage of customers' patterns there are three fireproof buildings, all patterns being recorded by the card system. The works drawing-office occupies the top floor of this building.

Fig. 4.—View in the Fettling Shop.

The loading bank runs at right angles for the full width of the works; double sidings are laid and the bay is served by a 10-ton overhead crane. One portion of the bank is laid off for the storage of boxes and the other portion for the assembly and dispatch of finished products.

On the south side of the loading bank is the smithy, hutch-building shop and joiners' shop and also the railway signal department. The hutch-building shop is equipped with Pels punching and shearing machines, large presses, bending rolls and beam-bending machines, pneumatic riveters, etc. In this shop also special fabricated work is carried out; at the time of our representative's visit some large pit cages were in course of construction.

In the smiths' shop are six Massey hammers ranging from 5 cwts. to 1 ton. Compressed air is supplied by a motor-driven compressor which is installed in the hutch-building shop. The joiners' shop is provided with up-to-date tools for the speedy and economic production of hutch underframes and composite hutch bodies.

Laboratory and Test House.

A well-equipped laboratory occupies the upper storey of the mechanical test house, in which is installed a 30-ton Buckton machine with fitments for taking the usual physical tests. Brinell machines are also installed.

The output of the foundry is approximately 500 tons of finished casting per month. Whilst all grades of castings are regularly made, cast-steel pipe-work and pressure castings form an important percentage of the total output. This foundry also supplies the largest number of tub-

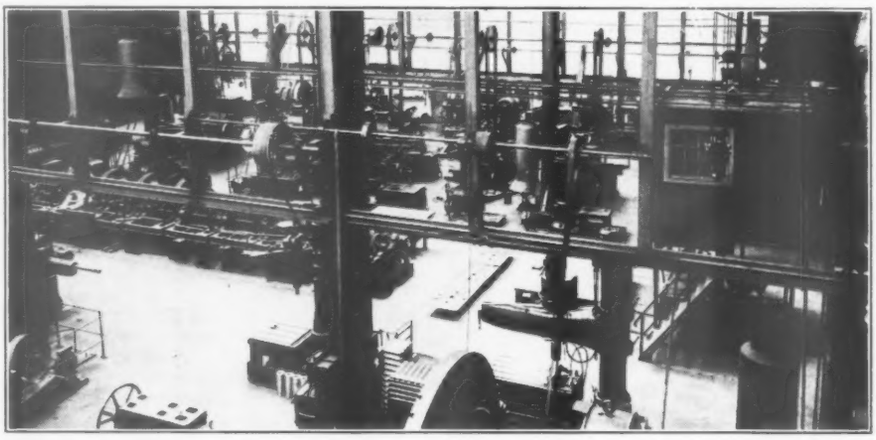

Fig. 5.—Part of Main Machine Shop of the North British Steel Foundry, Limited.

wheels and axles and rollers in Scotland. Manganese steel and alloy steels generally are regularly produced, and there has been experienced a very substantial increase in demand for such castings during the past few years.

"Steel Construction."—Messrs. R. A. Skelton & Company, Steel & Engineering, Limited, have issued Handbook No. 20-A, which is a completely-revised edition of their well-known Handbook No. 20. This new edition has been necessitated by recent changes in steel-construction specifications, notably a further revision in 1932 by the British Standards Institution of the British Standard Sections of Joists and Channels and the adoption by the Institution and by the London County Council of new codes governing the design of steelwork. The handbook contains 326 pages and embraces all the special features of No. 20. The principal alterations are a new chapter with numerous illustrations on arc-welded connections; special tables of safe loads conforming to the new L.C.C. code of practice and B.S.S. No. 449/1932, with an annotated *précis* of the specification; and fresh data on steel beams embedded in concrete, steel-sheet piling, and the Ministry of Transport's requirements for road bridges. The handbook is thumb-indexed and every effort has been made to ensure the accuracy of all details, and to facilitate reference. It may be obtained from Messrs. Skelton, Moorgate Station Chambers, London, E.C.2. (Price 10s. net, post free, or 7s. 6d. to owners of No. 20 handbook.)

Heat-Resisting Cast Irons.

By E. Morgan, M.Sc. (Associate Member).

(*Concluded from page* 34.)

Moulds.

This application includes steel-ingot moulds, non-ferrous moulds and glass moulds. Steel-ingot moulds require to be heat-resisting, since the conditions of service are such as to promote growth and distortion, cracking and oxidation, but for certain reasons, such as the question of disposal of used moulds, and not the least the complicated nature of the manufacture and treatment of the moulds in the steelworks, present-day practice is confined almost entirely to the use of moulds made from hematite pig-irons. The treatment which the moulds undergo in service at first sight appears to be simple and consistent; the molten steel is teemed, the inner surface of the mould is heated to a temperature which may rise to about 900 deg. C. in a few seconds, and in a very short time a solid shell of steel is formed. This shell contracts and leaves the mould, air enters the space between the ingot and the mould, and starts the process of oxidation. The average temperature of the walls of the mould is gradually rising, due to the heat evolved from the cooling mass of steel. After a time the ingot is stripped and the mould allowed to cool. That is to say, the conditions are such as to promote growth and scaling, and, if the material is brittle, cracks due to the high-temperature stresses set up. Actually, the useful life of the mould depends to a large extent on other factors as well, such as the method of moulding, design, which varies according to the requirements of the rolling mill, and the treatment received in the steelworks. It is found, for example, that moulds of almost identical composition, but made by different manufacturers, do not have the same useful life, even when used at the same steelworks. The number of casts obtained at different steelworks with moulds identical in every way and made by the same manufacturer also varies widely.

There is therefore, ample scope for investigation of the problem without departing from hematite irons—even were this possible. Some aspects of the problem have already been studied by Meszöly,[21] who gives curves to show that the life is materially affected by the design of the mould and by the composition of the pig-iron base. A suitable composition, according to this author, is total carbon 3.8 to 4.2 per cent.; combined carbon, 0.3 to 0.5 per cent.; graphite, 3.2 to 3.9 per cent.; silicon, 2.2 to 2.5 per cent.; and manganese, 0.8 per cent. (the sulphur and phosphorus are naturally very low). He prefers a structure which consists of fine lamellar pearlite with a fair amount of free ferrite round the graphite veins, and the hardness should be about 120 Brinell. On the other hand, others advocate the use of low total carbon irons containing much higher combined carbon contents with a view to obtaining increased strength and resistance to wear. Thus, Shiokawa[22] recommends total carbon, 2.5 to 3.3 per cent.; silicon, 1.0 to 2.0 per cent.; manganese, 1.0 to 0.5 per cent.; and chromium, 0.05 to 0.5 per cent. Meszöly dissociates himself entirely from this view, and maintains that what is required is a soft pig with a uniform dark-grey fracture—since the characteristics of pig-irons are largely retained on remelting in the cupola—and the actual mould should have a uniform structure and contain only a small amount of combined carbon. A low combined carbon also gives an iron having the highest thermal conductivity for a particular composition.

There appears to be little likelihood at the moment for any revolutionary change in policy with regard to the manufacture of steel-ingot moulds, save as regards what may arise with regard to the investigations mentioned above. On the other hand, there is scope for development involving radical changes in the compositions of non-ferrous moulds and glass moulds.

Regarding non-ferrous moulds, ordinary grey cast iron is not entirely suitable for brass-strip moulds, as it cracks in service, develops growth and has a tendency to evolve gas at the mould face when the dressing is too thin or on account of overheating.[25] Mild steel, although not prone to produce actual unsoundness in the surface of the brass ingot, since it does not give off gas when overheated, is entirely unsuitable, due to a combination of low thermal conductivity and high ductility with resulting rapid deformation due to the thermal stresses. The characteristics required of the material are freedom from growth, resistance to oxidation at the temperatures reached when casting, and ductility sufficient to withstand any tendency to crack under the influence of high thermal stresses. Good results are claimed for copper, since its high thermal conductivity reduces steep temperature gradients, and consequently, although very ductile, it is not given to distortion as in the case of mild steel.

With regard to cast irons, the most promising type would appear to be the non-growing austenitic type for reasons already stated, and there should be a future for this class of iron in this particular field.

Glass-bottle moulds require a smooth dense surface which is capable of taking a high polish, and a material which does not develop surface cracks, grow or oxidise at the temperature reached in the service. The average temperature may be 500 to 600 deg. C. with a surface temperature which may be as high as 700 deg. C. The surface must be sufficiently soft for any necessary engraving. The formation of any oxide on the surface produces a rough surface on the glass, and may also give rise to stickers. Good results have been obtained by the use of close-grained low-silicon irons cast against a chill. Hard iron is not suitable, because of the necessity which continually arises for repairing the surface by "peening." Good results are claimed for special heat-resisting steels for this purpose, and there are certain types of Nicrosilal cast iron which have proved extremely useful for the reason that, apart from their excellent heat-resisting properties generally, these irons are capable of taking a very fine surface finish which imparts a polish to the ware.

Obviously, the applications discussed above do not cover anything like the number of possible uses. No mention has been made of comparatively low-temperature applications such as various engine parts, but the above examples are sufficient to illustrate the fact that each particular application is a problem in itself and requires investigating in order to obtain the most suitable type of cast iron for the purpose.

The use of white cast irons with and without chromium and low-silicon grey irons containing small amounts of chromium and nickel has been established for some time, and details regarding the melting and casting of high-chromium, high-carbon white irons are given by MacQuigg.[18] The newer high-silicon irons are being used more extensively with the fuller realisation of the limitations of this type of material. This has only been possible after studying their reactions to certain service conditions, since laboratory tests cannot hope to supply all the data required, and for the progress that has already been made in this application the hearty co-operation of many ironfounders is largely responsible. Austenitic cast irons are of still more recent date, and there should certainly be a very promising field for their application when their properties have been worked out.

The author wishes to express his thanks to the Council of the British Cast Iron Research Association for permission to present this Paper and to place on record his appreciation of the assistance from his colleagues on the staff of the Association.

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Sampling and Analysis of Coke.

STANDARD SPECIFICATION.

The British Standards Institution have issued a British standard specification for the sampling and analysis of coke. We append a summary.

The minimum weights of gross samples specified have been determined after extensive trials on both oven and gas coke. The basis of the specification is the same as that used for small coal, viz., to determine the variability of the coke, and, from the theory of errors, to calculate the number of increments necessary for a specified degree of accuracy. The moisture content of coke was chosen as the most variable factor, and, by determining this separately in 50 increments, the average deviation from the mean (the average error) was found. This was done with cokes of different average moisture content and with different weights of increments.

It was found that the average deviation from the mean increased until the moisture content was 8 or 9 per cent., when it attained a constant value for higher moisture contents up to a limit, as shown by the tests, of 15 per cent. The results obtained with increments of 1 lb. were not generally satisfactory, but concordant results were obtained with increments of 2½ lbs., and as a consequence a weight of increment of 2½ lbs. has been adopted in the specification. The number of increments required to give a degree of accuracy such that, in 99 cases out of 100, the moisture content of the sample will be within ± 1 unit of the true moisture content, that is, the average moisture content of the consignment was calculated from the results of the tests. Since the variability of the moisture content of coke throughout a consignment depends largely on the proportion of different sizes of coke at the point of manufacture (small coke retaining more water during quenching than large coke), as well as on the proportion of water in the coke, provision has been made for the sampling of two classes of coke as follow:—*Class* 1.—Screened or unscreened coke containing not more than 10 per cent. below 2 in. at the place of manufacture and not more than 5 per cent. of moisture, graded coke (*e.g.*, coke nuts, cobbles, etc.). *Class* 2.—Other cokes.

The variability of the ash content of coke is less than that of the moisture content, except when the moisture present is about 1 per cent. For coke containing 2 per cent. or less of moisture, the minimum number of increments required to obtain a satisfactorily-representative sample has been fixed at 20, and this number of increments is also sufficient to ensure a satisfactory sample of ash, sulphur and volatile matter. In all other cases the number of increments required for correct sampling for moisture more than covers the requirements for sampling

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The German United Steel Works Corporation.

DECENTRALISATION SCHEME.

The Board of Control of Gelsenkirchen Bergwerks A.-G. (the Gelsenkirchen Mining Corporation), Essen, have authorised the directors to prepare a scheme for the transfer of the entire mining properties, including stocks, materials and other assets connected with the actual mining activities, to a new company, the Gelsenkirchen Corporation thus becoming purely a holding company.

In connection with the proposed plans of the Gelsenkirchen Corporation, the Vereinigte Stahlwerke (United Steel Works Corporation) is carrying out a decentralisation of its constituents into a number of independent operating groups, as a preliminary step towards the subsequent merging of the Steel Works Corporation, and its two parent companies, the Phœnix and Van der Zypen, with the Gelsenkirchen Corporation. This decentralisation is claimed to effect a rationalisation of the whole organisation and result in a more precise demarcation of the individual responsibilities of each component. The execution of the scheme depends upon a number of circumstances, and mainly the revision of various existing loans.

In discussing the question, the "Deutsche Bergwerks Zeitung" points out that judging from the general outline of the scheme the general administration of the whole concern will be vastly simplified and a greater measure of independence given to the various operating groups. The proposed merger represents a material advance in realising the policy of reorganisation of the Steel Works Corporation on a substantially productive basis. Although a decentralisation on the productive side and a merging on the administrative side are being carried through, this does not vitiate the fundamental structure of the Steel Works Corporation.

The first step in the evolution of the corporation was the combination of the promoting works into an undertaking under uniform management for the purpose of reducing the costs of production and increasing the margin of remuneration. Within the framework of the concern, schemes of technical and commercial rationalisation and reorganisation on the production side were carried through for some years, the result being the formation of, as far as possible, homogeneous working groups. From the experience gained it was found possible to take the second step and remove the working groups from centralised commercial and technical control and provide them with their own management working in collaboration with the entire concern. The third step which is now being entered upon to make the groups juridically independent is nothing more than a further development along the same path.

The Essen newspaper suggests that it is probably incorrect to assume that after complete decentralisation into independent groups, the Steel Works Corporation will remain a simple holding company or guarantee concern for the debts and debt services. An exchange of Corporation shares for those of the new companies is not provided for, which means that the Corporation will provisionally retain all the shares in the new companies, thus being the sole shareholder and naturally appointing the boards of directors. It is also probable that the Corporation will leave in the hands of the chief administration at Düsseldorf some control of the various administrative departments. In this way the danger of the new companies embarking on unsound schemes of expansion will be prevented. In the important questions concerning syndicate policy, international relations, etc., it is most probable that the Düsseldorf administration will retain its veto.

One of the most important functions of the Düsseldorf department will be to act as a clearing office for all financial business. The central adjustment of mutual debts and claims among the constituent works, as well as of the credits and liabilities of customers and foreign suppliers, will result in a very material simplification of the commercial organisation of the individual working groups.

Grouping of Works.

The Essen newspaper publishes a plan which gives an approximate idea of the grouping of works which has already been carried out by the Steel Works Corporation in recent years, and which can be readily transformed into independent companies.

The industrial connections are shown next to comprise the Stahlwerke Brüninghaus, A.G. of Werdohl, Vorhalle, and Westhofen, Friedrich Thomée A.G. of Werdohl, and the Bergbau und Hütten, A.G. of Friedrichshütte. Besides these, the Ruhrstahl A.G. of Witten is also expected to be included in this group.

In the raw materials department, the headquarters of which are at Dortmund, there are, first, the ore mines in the Siegerland (Bergverw. Siegerland), Lahn and Dill (Bergverw. Siegen), Bavaria (Bergverw. Bamberg), Central Germany, Luxemburg, Sweden, and Spain. The lime and dolomite group own works in Westphalia, the Dill district, and the Rhine province. The clay and quartz mines and fireclay works, which have Bonn as the managing centre, are located in the Westerwald district, the Dill district, Rhine province, and the districts of the Sieg and Hessen and in Saxony. Various works of a non-specified nature are mentioned, such as those of the Werk Wanhein of Duisburg-Wanheim, the Nordseewerke of Emden, and the Steinfabrik Wirges, of Wirges, Westerwald.

Works merchants of the Corporation are Heinr. Aug. Schulte, Eisen A.-G., Dortmund; the Thyssen-Rheinstahl A.-G., Frankfort on Main; the Thyssen Eisen und Stahl A.-G., Berlin; Raab, Karcher & Company, Carlsruhe, and the Werkshandel der Ver. Stahlwerke of Düsseldorf.

Concerning the iron and steel and finishing works, the report indicates that the West Hamborn group consists of the Aug. Thyssen Hütte, Hamborn, the Hochofen-Hüttenbetrieb Meiderich, the Hütte Ruhrort-Meiderich, the Hütte Vulkan and the Niederrheinische Hütte. The Mülheim foundry group comprises the Schalker Verein, Gelsenkirchen-Hochöfen; Friedrich Wilhelms-Hütte, Mülheim; the Concordiahütte, Engers; the Giesserei des Hüttenbetriebs, Meiderich; the Giesserei Hilden; the Giesserei Wanheim and the Zementfabrik Vulkan.

The Siegerland group centred at Siegen is composed of the Werk Wissen; Charlottenhütte; Eichener Walzwerk, Kreuztal; Werk Attendorn; Walzwerk Weidenau; Werk Nachrodt; Meggener Walzwerk; Werk Hüsten; Werk Bruchhausen, and the Verzinkerei Aschaffenburg. The wire group of Hamm consists of the Westfälische Union of Hamm; the Werk Lippstadt; the Drahtwerke Langendreer; Gebr. Knipping, Altona; the Seilindustrie Iburg, and the Metallweberei Brünn. Three works not included in any group are the Wuragwerk Hohenlimburg; the Eisenindustrie Menden und Schwerte and the Siegener Eisenbahnbedarf of Siegen. As further possible groups which have not yet been formed are mentioned the East ironworks as represented by the Dortmunder Union and the Hoerder Verein; the Bochumer Verein of Bochum and the Henrichshütte of Hattingen; and as further foundry groups, the Röhrenwerke Düsseldorf, the Röhrenwerke Hontrop, the Stahl und Walzwerke Thyssen of Mülheim, and the Aug. Thyssen Hütte of Dinslaken.

It is stated that the above grouping has already brought about a very considerable simplification in production and in technical and commercial management. Thus almost 90 per cent. of railway rails are rolled to-day at the Thyssen Hütte at Hamborn. Semis for sale are rolled chiefly at Hamborn, Bochum and Dortmund-Hoerde. Over 50 per cent. of the output of bars is produced at the August-Thyssen Hütte and at the Niederrheinische Hütte at Duisburg.

In the form hitherto followed, the formation of groups in so far as bulk products are concerned has been determined mainly by the question of freights. The works situated on the Rhine have been engaged primarily with export products, while the works in the East have supplied principally the inland market. The whole scheme represents a return to or rather a development of horizontal rationalisation.

Rubber Conveyor and Elevator Belting.—The British Standards Institution has issued British Standard Specification for rubber conveyor and elevator belting (B.S.S. No. 490—1933). Three grades of belts are provided for according to the class of material to be carried. Requirements are laid down covering the quality of the rubber cover and of the cotton fabric from which the belt is made. Clauses are included relating to the spacing of the joints in the plies together with tolerances on the width and other details of construction. Tests on the finished belt are specified and the methods in which these are to be made are given in full in a number of appendices. Recommendations are also included in one of the appendices with regard to installation conditions, whilst in another appendix the classes of materials with which the three grades of belt should be used are indicated. Copies of this specification may be obtained from the Publications Department, British Standards Institution, 28, Victoria Street, S.W.1. (Price 2s. net.)

Institute of British Foundrymen.

INSTITUTE ELECTS NEW MEMBERS.

At a Council meeting of the Institute of British Foundrymen, held at the Park Hotel, Cardiff, on Tuesday, June 20, the following were elected to various grades of membership.

Members.

A. H. Brackenbury, manufacturer, Sterling Foundry Specialties, Limited, London, S.W.1; W. F. Fisher, foundry manager, John Fowler, Limited, Sheffield; W. J. Rees, University Lecturer, Sheffield University; N. W. Riley, technical representative, Morgan Crucible Company, Limited, London; G. A. Taylor, managing director, Taylor & Sons, Limited, Briton Ferry; R. C. Tucker, B.A., metallurgical chemist, Newton Chambers & Company, Limited, Sheffield; V. E. Upton, district manager, Leigh & Sillavan, Sheffield; Man Singh Vij, proprietor, Greyshaw & Company, Delhi; H. J. V. Williams, draughtsman, John Williams, Limited, Cardiff; P. W. Hood-Williams, representative, General Refractories, Limited, Sheffield; E. G. Enticknap, proprietor, The Foundry, Alton, Hants; G. T. Monseur, pig-iron merchant, Liége; E. C. O'Brien, technical representative, British Pigirons, Limited, London, S.W.1; J. Sillavan, company director, Leigh & Sillavan, Manchester; G. B. R. Taverner, managing director, British Pigirons, Limited, London, S.W.1; Wm. Wilkinson, works manager, North Lonsdale Iron & Steel Company, Limited, Ulverston.

As Associate Members.

H. Blight, patternmaker, Gould's Foundries, Newport; H. H. Williams, brass moulder, J. Williams, Limited, Cardiff; S. Cooper, foundry foreman, J. E. Renshaw, Staines; W. A. Hodson, office superintendent, Farington Steel Foundry, Leyland Motors, Limited; T. T. Owen, representative, Revo Foundry Company, Tipton; S. Tongue, foreman moulder, Lancashire Steel Corporation, Irlam.

As Subscribing Firms.

Steel Band Conveyor Company, Limited, Birmingham; Barrow Hematite Company, Limited, Barrow; Geo. Rae Anderson, iron and steel merchants, Liverpool.

Sampling and Analysis of Coke.

(*Concluded from previous page.*)

for ash, etc. It was considered advisable to specify one method only for the sampling of coke for moisture, ash, sulphur, volatile matter and other constituents. The particle size to which coke may be crushed without loss of moisture, the minimum weight of sample to be taken for moisture determination, and the particle size to which coke may be crushed before sampling for ash have also been determined by extensive trials.

Methods of analysis included in the specification cover the determination of moisture (both in the air-dried coke and in the coke "as received"), volatile matter, ash, calorific value, sulphur and arsenic, together with such physical tests as the shatter test, bulk density and true specific gravity.

The use of this specification should reduce the disputes which frequently occur between buyer and seller, owing to the use of unsatisfactory method of sampling and analysis. Its use should also facilitate the sale of coke to specification, in which bonus and penalty clauses would encourage the production of finer and better cokes. The production of cokes of better quality would encourage the scope of their usefulness and so allow the production to be developed.

Copies of this specification (B.S.S. No. 496-1933) may be obtained from the Publications Department, British Standards Institution, 28, Victoria Street, London, S.W.1, price 2s. 2d. post free.

Report on Routine Methods for Testing Green Sands.*

BY THE SANDS AND REFRACTORIES SUB-COMMITTEE OF THE INSTITUTE OF BRITISH FOUNDRYMEN.

Introduction.

This Committee has been engaged in investigating methods of testing green sands for about two years. Progress has been rather slow, because it was felt that though much work has been devoted to investigating this question, both in America, Great Britain and the Continent, it was necessary that the subject should be explored from a detached and impartial standpoint, so that a procedure might be recommended which would not only be acceptable in Great Britain, but might recommend itself sooner or later for international acceptance.

The present Paper is a digest of the work of this committee from its commencement up to the present date, and deals only with methods and equipment for the *routine* tests of *green* sands, and does not attempt to include methods more suited for research work, though it is not intended to imply that some of the methods for routine control are necessarily unsuitable for research purposes or *vice versa*.

A report on the apparatus for testing other sands, such as dry sands and oil-sand cores, etc.,

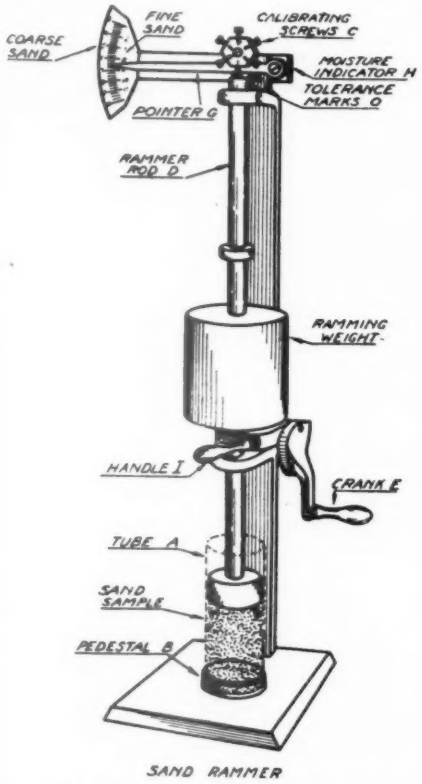

FIG. 1.—THE A.F.A. STANDARD RAM MACHINE.

may follow at a later date, though it should be mentioned that these tests have been kept in mind when dealing with certain apparatus for testing green sands, so that as far as possible the equipment will be capable of testing dry and oil sands as well as all kinds of iron, steel and non-ferrous foundry sands.

Simplicity, speed and sufficient precision for control purposes have been sought; together with equipment which is easily manipulated, robust, portable and as independent as possible of water and gas supplies.

The present Paper will only cover tests for:—(1) Determination of moisture, (2) determination of bond strength and (3) determination of permeability.

Moisture.

The need for a very quick method of determining moisture in sands has become increasingly apparent, since the ill-effects of varying quantities of moisture may lead to failures in quantity-production work. The following methods have been considered by the committee in addition to the ordinary laboratory method:—(1) Dietert's moisture indicator fitted to the A.F.A. standard ram, (2) the Grubb moisture tester, (3) "Speedy" moisture tester, (4) McIlvaine's electrical method and (5) Richardson's modified electrical method.

Personnel of the Sub-Committee.

W. Y. BUCHANAN: Chief Metallurgist; Messrs. John Lang & Sons, Limited, Glasgow.

A. CAMPION: F.I.C., Consultant Foundry Metallurgist, Glasgow.

B. HIRD: Foundry Manager; Guest Keen Baldwins, Limited.

F. HUDSON: Chief Metallurgist; Messrs. Glenfield & Kennedy, Limited, Kilmarnock.

W. J. REES, M.Sc., F.I.C., Head of Refractories Dept., Sheffield University.

R. J. RICHARDSON: Foundry Manager; Messrs. Brown, Lenox & Company, Limited, Pontypridd.

T. R. WALKER, B.A., Chief Chemist; Messrs. The English Steel Corporation, Limited, Sheffield.

DR. J. G. A. SKERL: B.C.I.R.A.

N. D. RIDSDALE (Convener), Consultant Foundry Metallurgist, Middlesbrough.

Dietert's Moisture Indicator. — This method, which is described in American literature,[1] does not claim to be more than an indication of the moisture content. As is well known, it depends upon the increased compaction of sand in proportion (more or less) to the increased moisture when rammed in the A.F.A. standard ram (Fig. 1). A separate calibration has to be made for each kind of sand thus limiting its general utility.

"Speedy" Moisture Tester. — This patented tester (British Patent No. 33985), which has been described recently in THE FOUNDRY TRADE JOURNAL,[2] depends upon the principle of mixing a weighed quantity of sand with powdered-calcium carbide in a closed container (Fig. 4) connected with a pressure gauge. The moisture in the sand generates acetylene gas in proportion to the amount of water present. The pressure produced is in proportion to the amount of gas evolved so that the dial of the pressure gauge can be calibrated direct in per cents. of moisture. The table below shows a list of tests made by the ordinary oven-drying method and by a "Speedy" tester. The average difference is minus 0.3 per cent. moisture, which is considered very satisfactory for a rapid-control test, which can be made in about three minutes, especially when it is remembered that a variation of about ± 0.1 per cent. mixture is not unlikely in the oven-dried samples.

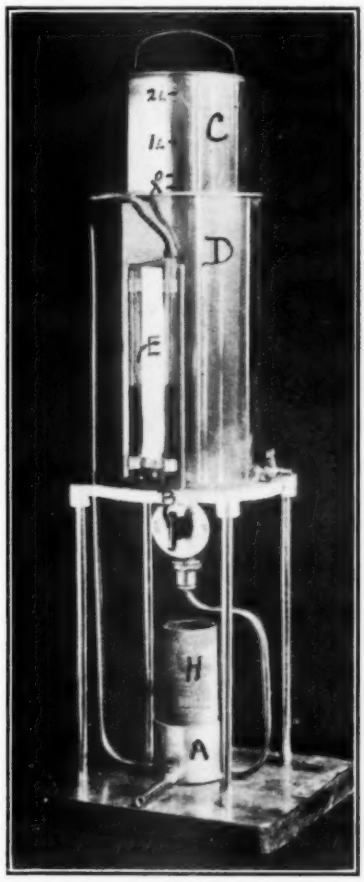

FIG. 2.—THE A.F.A. STANDARD PERMEABILITY APPARATUS.

	Oven dried per cent. moisture.	Speedy per cent. moisture.	Difference.
Erith mild loam	2.8	2.4	− 0.4
" "	4.9	4.4	− 0.5
" "	7.2	6.8	− 0.4
" "	7.8	7.9	+ 0.1
" "	8.9	8.6	− 0.3
" " + 5 per cent. coal dust	2.9	2.3	− 0.6
" " + 5 " " "	4.7	4.1	− 0.6
" " + 5 " " "	6.6	6.1	− 0.5
" " + 5 " " + 5 per cent. blacking	4.3	4.1	− 0.2
" " + 5 " " + 5 " "	5.9	5.4	− 0.5
Yorkshire steel moulding sand	7.6	7.6	± nil
" " " "	6.0	6.0	± nil

Grubb Moisture Tester. — This apparatus (Fig. 3), which is also described in American literature,[3] dries a sample of sand in a few minutes by forcing electrically-heated air through the sample, and a computing pendulum balance eliminates the time consumed in exactly weighing the sample. It is claimed that one determination may be made in four minutes, or with a battery of four or five heaters, forty tests may be made in one hour.

* Presented at the Cardiff Conference of the Institute of British Foundrymen.

McIlvaine's Electrical Method. — This is described in American literature[4] and is also referred to in Proceedings of the Institute of British Foundrymen. It has been tested and reported upon by the British Cast Iron Research Association.[5] This instrument, which really measures the increased conductivity of sand when the moisture is increased, needs calibrating for each kind of sand used, and is not regarded as being of sufficient accuracy.

Richardson's Modified Electrical Method.— This process depends upon the same principle as the McIlvaine's moisture method, but has the advantage of using the standard test-piece employed for the permeability test. The usual metal cylinder, in which the 2-in. by 2-in. sand test-piece is formed, is replaced by a cylinder of similar dimensions, but made of ebonite or any similar strong non-conducting material. The removable metal plug in the base of the cylinder rests upon a piece of ebonite in order to insulate it from the base of the stand. The sample of sand is rammed in the usual manner to form a 2-in. by 2-in. A.F.A. core, and after the third blow the plunger of the ram is left in contact with the sand specimen, and a current of standard voltage (say, 30) is passed from a dry battery through the rammed specimen and a reading is taken on an indicator, which is in series with the test. (See diagram, Fig. 5.) The readings increase with the moisture content, and each indicator needs to be calibrated for each kind of sand, using the same water as is used for the sand in the foundry. A graph should be plotted having indicator readings and per cent. moisture as ordinates, so that the percentage of moisture may be at once found by reference to the graph. A suitable indicator is a simple double-range volt-meter as used for wireless purposes. Fig. 6 shows a typical graph for both a steel- and iron-foundry sand. It has been found that different types of sand of the same moisture content may show considerably different readings on the meter when a current of standard voltage is passed through the rammed specimen. As an illustration of this, at a standard voltage of 30 the meter reading with dense Erith mild sand containing 8.0 per cent. moisture was 2.5, whilst the reading with an open-grained steel-moulding sand containing 8 per cent. moisture was only 0.55.

Tests made so far with the addition of 5 per cent. coal dust + 5 per cent. coke dust (passing 80 mesh) indicate that this amount of carbonaceous matter does not appear appreciably to affect the electrical conductivity of the moist sand, but this is being further investigated.

To sum up, the most rapid and accurate of the methods for general utility we have examined for routine control is No. 3, viz., the "Speedy." All special apparatus for quick-moisture testing should be checked periodically by the orthodox laboratory method of drying at between 105 and 110 deg. C. to constant weight.

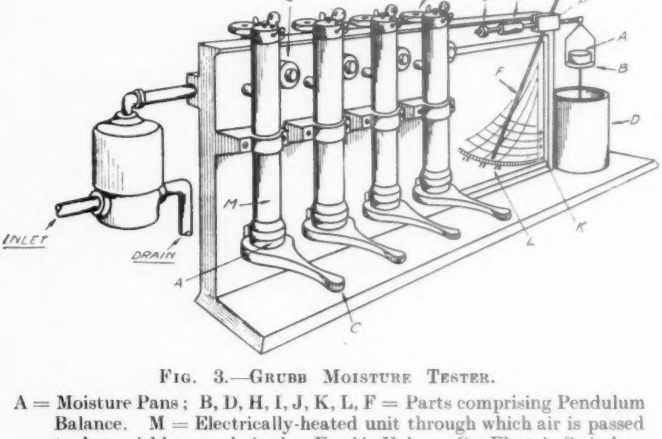

FIG. 3.—GRUBB MOISTURE TESTER.

A = Moisture Pans; B, D, H, I, J, K, L, F = Parts comprising Pendulum Balance. M = Electrically-heated unit through which air is passed to dry quickly sample in A. E=Air Valve. G=Electric Switches.

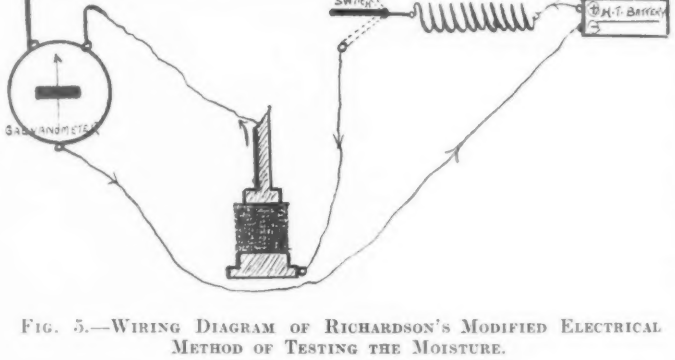

FIG. 5.—WIRING DIAGRAM OF RICHARDSON'S MODIFIED ELECTRICAL METHOD OF TESTING THE MOISTURE.

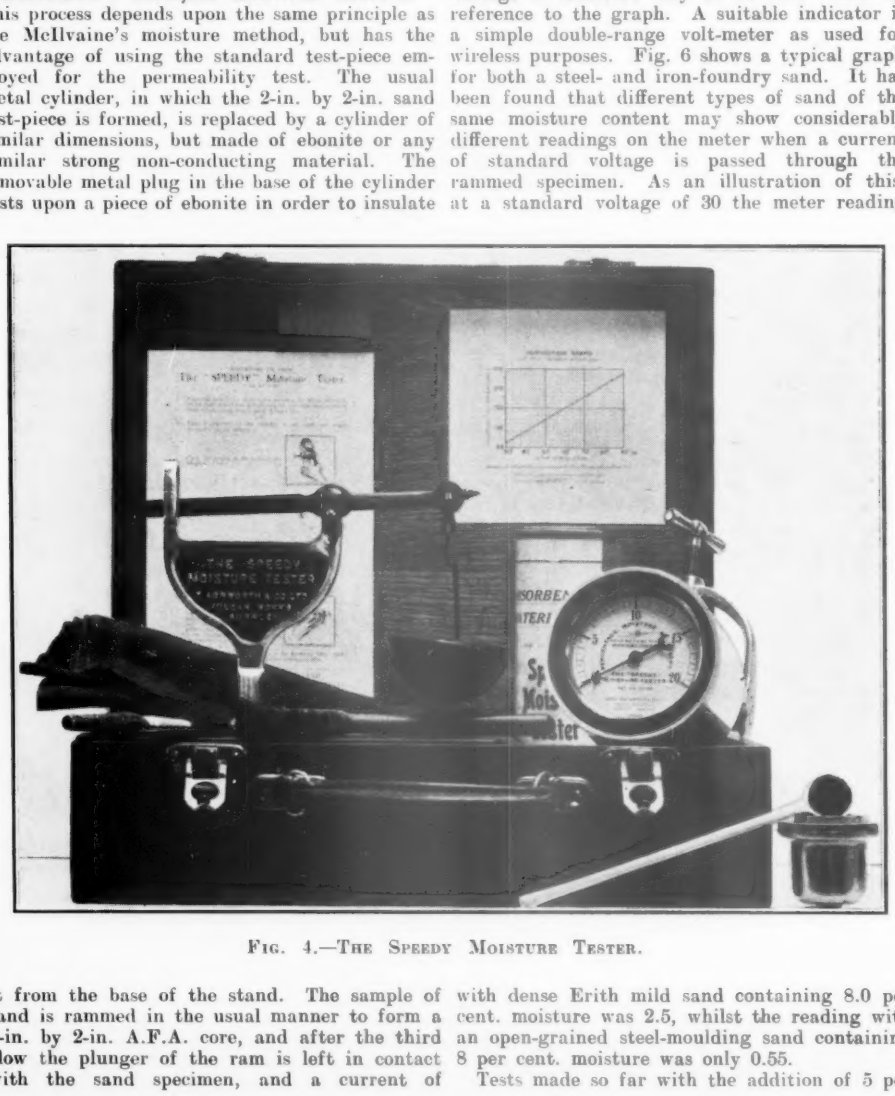

FIG. 4.—THE SPEEDY MOISTURE TESTER.

Test-Pieces for Permeability and Bond Strength.

The test-pieces which have received special consideration are the A.F.A. 2 in. dia. by 2 in. long, the B.C.I.R.A. compression strength permeability test-piece 1.128 in. dia. by 2.256 in., with an area of 1 sq. in., and the B.C.I.R.A. permeability test-piece 7.14 cm. dia. and 20 cm. long (approximately $2\frac{3}{4}$ in. dia. by 8 in. long). In the endeavour to select a suitable test-piece the following points were considered:—(1) The need for a test-piece of such dimensions as would give a reasonably accurate measure of the permeability and/or bond strength; (2) the desirability of having a test-piece of convenient size without being too bulky and one which could be duplicated quickly under standardised conditions for repeat tests; (3) the desirability of simplifying the tests by having a single test-piece suitable for both permeability and bond strength; (4) the desirability of adopting a standard method of ramming which most nearly imitates practical conditions; (5) the desirability of using a test-piece which might, in due course, become internationally acceptable.

Dealing with the above items accuracy depends upon:—(*a*) Ramming in such a manner as to obtain reasonably uniform compaction throughout its length; (*b*) dimensions sufficiently large to minimise experimental error in testing, and (*c*) a ratio of diameter to length which, in the case of compression-strength tests, will give a satisfactory shear effect when fractured.

(*a*) *Compaction.*—Uniform compaction calls for some form of standard ramming and tends to eliminate any method which depends upon hand ramming. The two test methods of standard ramming we have examined are the drop-weight ramming as advocated by the A.F.A.[6] and "single" or "double" compression as advocated by Buchanan.[7]

The A.F.A. standard ram is very simple and convenient and quite satisfactory for 2-in. dia. by 2-in. long test-pieces. It is not, however, so satisfactory for ramming a test-piece in which the length is much greater that the diameter unless some provision is made for delivering blows to each end of the test-piece such as by reversing the specimen.

Buchanan's double-compression method works very well and is especially useful for forming test-pieces having a length equal to twice the diameter, but one drawback is that it is not possible to obtain a direct comparison of perme-

ability and bond strength between two different sands of different density. For example, suppose a moulder had been trained to ram up a certain kind of mould in a standard way and one day he was provided with a supply of a sand from a new source and proceeded to ram it exactly the same way, the foundry manager

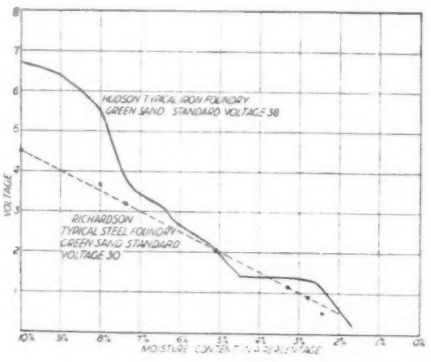
HUDSON TYPICAL IRON FOUNDRY GREEN SAND STANDARD VOLTAGE 38
RICHARDSON TYPICAL STEEL FOUNDRY GREEN SAND STANDARD VOLTAGE 30
VOLTAGE
MOISTURE CONTENT PERCENTAGE

FIG. 6.—GRAPHS OBTAINED FROM RICHARDSON'S MOISTURE TESTER.

might want to know how the permeability and bond strength of the new sand would compare with that of the old. If the A.F.A. ram were used for making a test on both sands the comparison would be simple, because the weight and number of blows would be exactly the same in each case, but if the tester had to rely on Buchanan's double-compression method the comparison between the two sands might be appreciably different if the density of the two sands were different. However, the double-compression method has the advantage that it allows the testing of the sand at the actual density used in the foundry. It is considered, therefore, that for routine-control tests the A.F.A. standard rammer is to be preferred, whilst for more detailed information comparing the properties of sands on a range of different densities Buchanan's method is advantageous.

(*b*) and (*c*). In order to obtain some practical information relating to the minimum size of the test-piece and the ratio of length to diameter, a series of tests for permeability and bond strength have been made on test-pieces of the following dimensions:—(1) 2 in. dia. by 2 in. long (standard rammed, A.F.A.); (2) 2 in. dia. by 2 in. long (squeeze-rammed, Buchanan); (3) 1.128 in. dia. by 2.256 in. long (squeeze-rammed, double-compression, Buchanan); (4) 2 in. dia. by 4 in. long (A.F.A. standard rammed test-pieces, one placed on top of the other); (5) 2 in. dia. by 4 in. long (squeeze-rammed, Buchanan); and

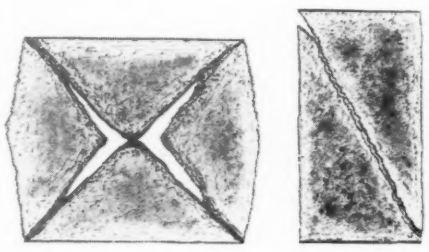

FIG. 7 A.F.A., FIG. 8 B.C.I.R.A.—TYPES OF FRACTURES OBTAINED BY THE TWO METHODS.

(6) 7.14 cm. by 20 cm. (squeeze-rammed, Buchanan, in 4 stages).[10]

Two widely-different types of sand were selected, so that any discrepancy that might occur would tend to stand out conspicuously. The permeability was determined by forcing a definite volume of air through each specimen and noting the pressure and the time taken. The permeability was then calculated in terms of A.F.A. units, since it seemed more satisfactory to express it as the volume of air per minute passing through sand of unit area and thickness at a pressure of 1 gram per square centimetre.

So far, the results of these tests for permeability, which have not yet been fully investigated, show a close comparison between each kind of test-piece. Incidentally, it shows that there is a direct comparison between the A.F.A. permeability tests and B.C.I.R.A. permeability tests provided that the latter are squeeze-rammed by Buchanan's method to the same apparent density as the A.F.A. standard-rammed specimen. To give one illustration of this: the volume of the A.F.A. 2-in. by 2-in. test-piece is approximately 103 c.c., whilst the volume of the B.C.I.R.A. permeability test-piece actually used in this instance was 784 c.c. The weight of sand required to form the A.F.A. test-piece was 180 grms., giving an apparent density of 1.75, whilst the weight of sand required to form the B.C.I.R.A. test-piece at the same apparent density of 1.75 was 1,370 grms.

TABLE I.—*Bond Strength in relation to Size of Test-Piece.*

Test-pieces.		Bond strength (compression).			
		Erith mild moist 8 per cent. Ap. den. 1.14.		Yorkshire moist 7 per cent. Ap. den. 1.75.	
Size.	Description.	Lbs.	Lbs. per sq. in.	Lbs.	Lbs. per. sq. in.
Dia. length.					
2 in. × 2 in.	Std. rammed A.F.A.	19.8	6.3	37.0	11.8
2 in. × 2 in.	Squeezed, Buchanan	20.3	6.5	34.8	11.1
1.128 in. × 2.256 in.	Squeezed (D.C.) (B.) B.C.I.R.A. compression ..	6.1	6.1	9.7	9.7
2 in. × 4 in.	2 A.F.A. std. rammed test-pieces, 1 placed on top of another	19.4	6.2	35.0	11.1
2 in. × 4 in.	Squeezed (Buchanan) in 2 portions as for B.C.I.R.A. Perm. test-piece	20.1	6.4	33.0 (Single test)	10.5

Tests made by the B.C.I.R.A. coal-gas method[9] cannot readily be converted into A.F.A. permeability units, because the volume of coal gas is not readily obtained with any great precision.

Table I shows a comparison of bond strength (compression) tests on the same range of test-pieces, and here it will be seen that there is a reasonable relationship in lbs. per sq. in. compression strength between the 2-in. by 2-in. A.F.A. standard-rammed, the 2-in. by 2-in. squeeze-rammed, the 2-in. by 4-in. A.F.A. standard-rammed test-pieces one on the top of another, the 4-in. by 2-in. squeeze-rammed and the 1.128-in. by 2.256-in. B.C.I.R.A. compression test-piece. It was observed that generally the remains of the fractured 2-in. by 2-in. squat test resembled a cone with an inverted cone standing on the peak (see Fig. 7), whilst the fracture of the test-pieces having a length equal to twice the diameter was usually a distinct shear (see Fig. 8). The shear effect of the longer test-pieces conveys a more favourable impression to the scientific mind, and there appears to be a satisfactory relationship between the different test-pieces. It should be mentioned that there is some advantage in using a test-piece of large dimensions, especially for weak sand.

This subject has been dealt with at length by various investigators,[5] but for those preferring a test-piece having a length equal to twice the diameter a simple way out seems to be to use one A.F.A. test-piece placed on the top of another.

The sub-committee is refraining from putting forward a definite recommendation as to the best dimensions of test-piece which should be adopted until any other workers who wish to do so have had an opportunity of confirming or otherwise this series of tests, which were made with the express purpose of finding out *by trial* the relative merits of different-sized test-pieces, and noting what relationships, if any, existed between each.

Permeability.

The three types of apparatus which have been considered are:—(1) The A.F.A.; (2) a modification of the A.F.A. recommended by Mr. R. J Richardson, and (3) the B.C.I.R.A. apparatus.

The A.F.A. apparatus is fully described in that Association's publication entitled "Testing and Grading Foundry Sands" (new revised edition March, 1931). As is well known, it consists essentially of a tank with a floating bell having a water seal. The bell encloses rather more than two litres of air and when it descends the air is forced at constant pressure through the standard rammed specimen of sand. The permeability is calculated by noting the time required to force 1 or 2 litres of air through the sand specimen. Meanwhile, the pressure is observed and the permeability is calculated in cm.-grm.-minute units; *i.e.*, the number of c.cs. of air which would pass through 1 c.c. of sand in one minute if the pressure difference is 1 gram per sq. cm. It has been found that the product of the pressure (in terms of water head) and the time

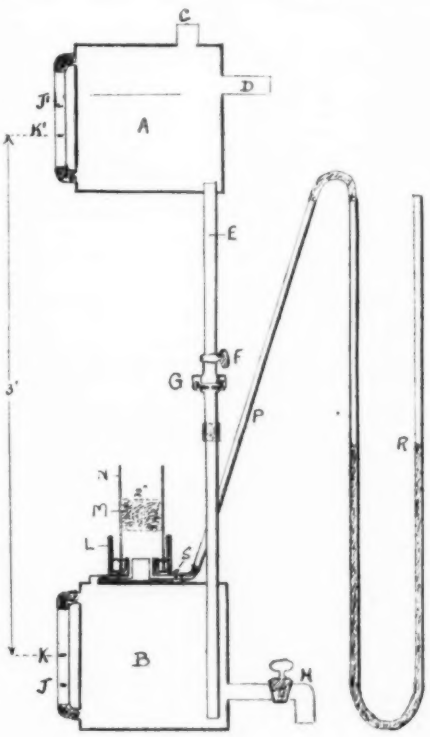

FIG. 9.—RICHARDSON'S PERMEABILITY APPARATUS.

is a constant. The pressure varies very little with widely different types of sand, whilst the time varies almost inversely as the permeability; *i.e.*, a dense sand takes much longer than an open sand for 2 litres of air to be forced through it.

The A.F.A. apparatus is very quick in action, reasonably portable, and independent of water or gas supplies. Repeat tests may be carried out

without any difficulty. Fuller particulars for carrying out tests by this method are given in Appendix A.

Mr. R. J. Richardson's modification consists of two 2-gall. tanks, one mounted concentrically above the other and having dimensions as shown in Fig. 9 of Appendix B. A 3-ft. head of water is allowed to flow from the top tank to the lower part of the bottom one and this forces air in the upper part of the bottom tank through the rammed specimen of sand. The rate of flow from the top tank can be controlled by standard nozzles inserted in the fall pipe. Sands of high permeability require a fairly large nozzle, *e.g.*, $\frac{3}{16}$ in. dia., whilst sands of low permeability can be tested more conveniently by using a small nozzle, *e.g.*, $\frac{1}{8}$ in. dia. Fuller particulars for operating this apparatus are given in Appendix B.

In contrast to the A.F.A. apparatus, which forces air at a relatively low pressure through the specimen in a relatively long time, the Richardson apparatus forces air at a relatively high pressure through the specimen in a relatively short time. However, repeated experiments have shown that the product of the time and pressure, when testing the same sample of rammed sand, is, for all practical purposes, a constant; *e.g.*, a sample of rammed sand tested in the A.F.A. apparatus might take 3 min. at a pressure of 10 cm. water, whilst the same sample tested in Richardson's apparatus might take 0.4 min. at a pressure of 75 cm. of water, the product of time and pressure in each case being 30. It is thus possible, after having found the time required for forcing two litres of air through a standard rammed sand of a certain type, to accept this time as constant and read only pressures when making daily routine tests on the same type of sand. By this means the use of a watch or stop watch is eliminated and the procedure is simplified. This advantage will be appreciated mainly in a foundry where there is no metallurgical laboratory and where the sand testing is carried out by, say, an apprentice moulder.

Table II shows a series of tests made by members of the committee and also by Dr. H. Ries, Technical Director of the A.F.A. committee on moulding-sand research. This table shows clearly the relationship between the A.F.A. apparatus and Richardson's modification, and also shows the correlated results as found in the B.C.I.R.A. permeability apparatus when using coal gas.

TABLE II.—*Showing comparison between permeability tests in* (1) *A.F.A.*; (2) *Richardson's, and* (3) *B.C.I.R.A. apparatus, using F. Hudson's standard green sand at 7 per cent. moisture and 2 in. × 2 in. test-pieces for A.F.A. and Richardson's apparatus, which were drop rammed by standard A.F.A. method. The apparent density was 1.50.*

Authority.	A.F.A. No. found on A.F.A. Ap.	A.F.A. Perm. No. calculated from Richardson's apparatus using jet.					B.C.I.R.A. Perm. No. on B.C.I.R.A.	
		$\frac{1}{16}$ in.	$\frac{1}{8}$ in.	$\frac{3}{16}$ in.	$\frac{1}{4}$ in.	$\frac{5}{16}$ in.	secs.	press.
F. Hudson	—	51.0	50.4	52.5	50.5	53.0	29	7 cm.
T. R. Walker	51.9	—	50.5	50.7	—	—	32	7 cm.
N. D. Ridsdale	50.5	50.7	—	51.4	51.2	—	—	—
Dr. H. Ries (U.S.A.)	51.0	—	—	—	—	—	—	—

B.C.I.R.A. Apparatus.—This is fully described in the B.C.I.R.A. Research Report No. 73, May, 1930, edition, entitled "Methods of Testing for Foundry Moulding Sands." The original apparatus only provides for hand ramming of the specimen and the use of coal gas, but more recently[10] Mr. W. Y. Buchanan has described an improved method of squeeze-ramming the sand in four portions so as to ensure reasonably even ramming throughout the cylinder. Dr. Skerl has also recently provided an air tank (Fig. 10) for forcing air at constant pressure through the specimen when a supply of gas is not available. The air tank is similar in principle to the tank on the A.F.A. apparatus. As previously mentioned in connection with the section dealing with test-pieces, permeability determinations by the B.C.I.R.A. revised method can be correlated with those done by the A.F.A. method at the same apparent density. The B.C.I.R.A. apparatus has been modified recently to permit of test-pieces of varying dimensions, including those of 1.128 in. dia. by 2.256 in. long, and 2 in. dia. by 2 in. long (see Fig. 11).

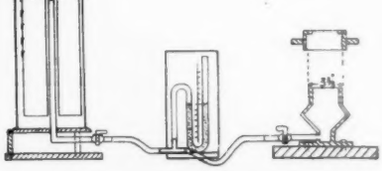

FIG. 10.—B.C.I.R.A. PERMEABILITY APPARATUS FOR FOUNDRIES WITHOUT GAS SUPPLY.

It consists of a bell tank and tap system which will allow the flow of 500, 100, 1,500 and 2,000 c.cs. of air under 10-cm. pressure to pass into distributing chamber into which any of the core boxes, containing the required test-piece, either B.C.I.R.A. large permeability (as for gas determination), the B.C.I.R.A. compression test-piece (as rammed by the Buchanan double-compression method) or the A.F.A. test-piece (as rammed by the drop-weight method) can be fitted. The core boxes are fixed in position by means of washers and the screw flange making airtight joint. The manometer registers the back-pressure set up by the core.

Bond Strength.

The A.F.A. bar-strength green-sand (Doty method) tentative standard, described in the A.F.A. publication just referred to[6] was unanimously considered as being unsuitable for rapid-control tests, and it was agreed that some single form of compression test would be more acceptable. Any apparatus which would apply a steadily increasing even load to the ends of the cylindrical test-piece and indicate the pressure applied would meet the case. Examples are: The Adam's design, the Dietert design and the Federal Foundry Supply Company's design—all of which are referred to in the A.F.A. publication; also the B.C.I.R.A. design described in B.C.I.R.A. Research Report No. 73.

The B.C.I.R.A. design of compression-strength tester (Fig. 12) is the only one of the above made in Great Britain and is simple and inexpensive. Recently certain improvements have been incorporated to enable the pressure to be applied to the specimen in such a way as to overcome inaccuracies which develop when the screw thread wears. The spring balance is now obtainable for reading up to 100 lbs. pressure. With these modifications this machine is regarded as being reasonably satisfactory for the purpose.

Conclusion.

This sub-committee recognises that new and valuable ideas sometimes come through unexpected channels. It therefore welcomes any fresh experience or constructive proposals, and also the experience of those who have used, over a period, any of the sand-testing methods mentioned in this Report.

It is not the purpose of this Paper to discuss at length the *merits* or *application* of sand testing, but this committee feels that next in importance to investigating and recommending simple and satisfactory methods of testing green sands is the need for a campaign to urge upon founders the benefits which they will obtain by systematically using such tests daily in the foundry. The regular control of moisture content of green- and dry-sand moulds is a matter of first importance, whilst the improved properties which are obtainable by suitable milling and the economies which can be effected in the use of new sand can only be revealed by working to a given bond strength and permeability and making regular tests to keep the sand up to the standard.

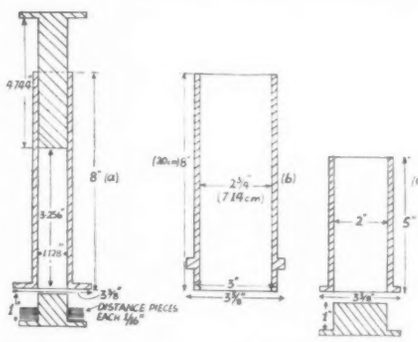

FIG. 11.—CORE BOXES USED IN THE MODIFIED B.C.I.R.A. PERMEABILITY APPARATUS.

(*a*) B.C.I.R.A. Compression Test-Piece rammed by Buchanan Double-Compression Method. (*b*) Permeability Core as used when determining the Permeability and using Coal Gas. (*c*) The A.F.A. Permeability and Compression Core as rammed by the Drop-Weight Method.

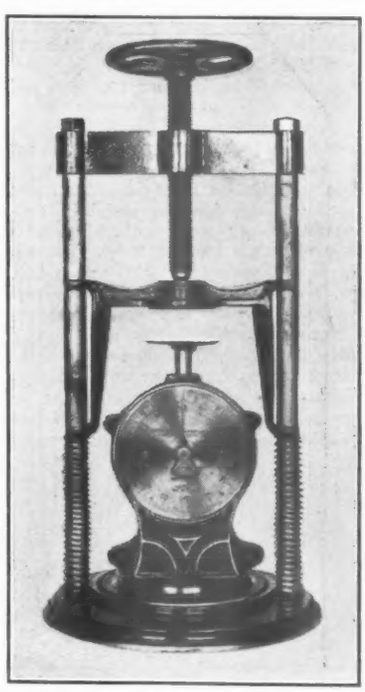

FIG. 12.—THE B.C.I.R.A. COMPRESSION STRENGTH TESTER.

(*Continued on page 56.*)

The Properties of Pig-Irons.*

By J. E. Hurst.

From the very early days of ironfounding the view has been held persistently that the qualities and properties of pig-iron are not wholly defined by the chemical composition as is generally understood. It is held that distinct differences in properties exist between various brands of pig-irons which cannot be predicted from an examination of the ordinary chemical analysis. These differences in character, quality, properties or fracture have gradually come to be referred to as inherent or intrinsic properties and their existence in cast iron after remelting and working in the foundry is discussed under the title heredity in pig-irons. These views have been, and are held by many of the leading authorities in ironfoundry matters, as is well known. It is therefore unnecessary to quote their opinions and experiments in support of these views. It is, however, necessary to point out that there have been, and still are, those who entirely disagree with these views and insist that the chemical composition is in itself sufficient to define all the qualities and properties of pig-irons and who regard the differences in properties which might exist in commercial pig-irons as being due to such matters as cooling conditions and their possible persistence of quality due to heredity on remelting as all "bunkum."

More Research Needed.

The whole matter is therefore still somewhat in the realm of controversy, and as far as can be seen, only experimental work undertaken with the definite object of exploring these properties in pig-irons, can carry matters any further. These alleged differences in properties are not confined only to the mechanical strength, but include such things as fluidity and life; the liability to drawing, shrinking and cracking; the cleanness and freedom from slag, dirt and kishy matters. The difficulty of investigating such of these properties as enumerated in pig-irons will be apparent, and is due almost entirely to the difficulty of evaluating these properties in quantitative terms. Difficulties of this nature are least in the case of the mechanical strength properties and some work has been done in this direction. The author himself has already published the results of a comparative study† of some of the strength properties of a number of British pig-irons after remelting and casting under standard conditions. These results in many directions give ample support to the existence of inherent or intrinsic properties.

The Manual Breaking Tests.

The practical foundryman's belief in inherent strength properties of pig-iron appears to be derived from the common works method of comparing the strengths of different irons by breaking them with a hammer and observing the difficulty of breaking. This method, which superficially appears to be of a somewhat rough-and-ready character, may actually be very sensitive in differentiating between the strength of different specimens. By long practice and experience individuals develop a remarkably accurate and firm skill, and the observer is able to classify irons as tough, strong, weak, dry or brittle. These and other similar phrases convey a definite idea of the strength properties to those accustomed to use the breaking method. They obviously are lacking in their capacity for quantitative expression, and in attempting to evaluate these differences in a more quantitative fashion the foundryman is often surprised to find that the ultimate breaking strength either in tension or under conditions of transverse bending bears no relation to his experience in breaking with the hammer. For example, he frequently encounters specimens of hematite pig-irons extremely difficult to break, yet showing quite ordinary ultimate breaking strength results when tested. On the other hand, specimens of phosphoric foundry irons showing quite superior ultimate strength values are found to be capable of being broken with the greatest of ease with the hammer.

TABLE I.—*Tensile Strength and Stiffness Compared.*

Specimen.	T.C.	C.C.	Gr.	Si.	Mn.	S.	P.	Tensile strength (tons per sq. in.).	Pig breaker's report
Semi-cold blast iron (blast-furnace product)	3.60	0.33	3.30	1.86	0.88	0.079	0.32	14.9	Very tough and strong
Foundry iron ..	3.55	0.85	2.70	2.45	0.40	0.062	1.32	17.3	Brittle and weak

As an illustration of this sort of thing, two cases are given in Table I. The first case consists of a low-phosphorus semi-cold blast iron which shows a tensile strength of 14.9 tons per sq. in. This is compared with a phosphoric foundry iron showing a tensile strength of 17.3 tons per sq. in. on an exactly similar test-piece cast under identical conditions. In the former case the pig-breaker reports this iron to be tough and strong and in the latter "brittle and weak." It is necessary to state at this point that the expression tensile strength as used throughout this Paper is the strength determined in the manner laid down in B.S.I. Specification 5,004, and annular drum-form specimens cast by the centrifugal casting process have been used except where otherwise stated.

The actual experience of breaking materials with a hammer is a complex phenomenon and involves many considerations other than the ultimate breaking strength under simple stress conditions. The properties of stiffness, elasticity, ductility, plasticity are amongst the other factors which have a bearing on the experience undergone by an observer in breaking materials with a hammer. In illustration of this, it is pointed out that it is possible to have a piece of gun-metal, for example, and a piece of cast iron, both showing the same ultimate breaking strength in tension, yet those who are familiar with these two materials will realise immediately that the difficulty of breaking them with a hammer is vastly different in each case.

Ascertaining Stiffness.

It is possible in mechanical-testing procedure to determine quantitatively the property of stiffness and also various attributes of the elastic properties. It is not proposed to discuss in detail the testing procedure adopted, as this has been dealt with in the Manchester Paper referred to and in other Papers by the writer. Briefly, a form of modulus of elasticity, known as the En value, can be used as a comparative measure of the stiffness. It is suggested that the included area of the stress-strain curve, in that it is proportional to the energy absorbed in stressing and breaking the material, is in itself a close measure of the experience undergone in the ordinary breaking of materials with a hammer. This value of the total area of the stress-strain curve is frequently spoken of as the resilience value. Whilst strictly orthodox, British engineers attach a slightly different meaning to this phrase. Continental engineers use it in this sense, and it is used in this sense in this Paper. The stress-strain curve in addition is of value in that its shape gives some indication of the character of the deformation undergone by the material during loading. In the testing procedure used by the writer, in addition to the ultimate breaking strength, the modulus of elasticity, the stress-strain (stress-deflection curve) curve and permanent-set value have been determined. As an illustration of the type of results obtained it is interesting to refer to Table II, which gives these properties for the two irons described in Table I. It will be noticed at once that the total area of the stress-strain curve or resilience value coincides with the pig-breaker's report. In addition, in this case the En value is lower in the "tough strong" iron, that is to say, this sample is less stiff and, further, the permanent set value is greater. All these attributes can be readily appreciated and would go to make up the pig-breaker's experience.

A collection of stress deflection diagrams obtained from similar specimens of different pig-irons, remelted and centrifugally cast, were published on page 338 of THE FOUNDRY TRADE JOURNAL, November 26, 1931. A variety of different types present themselves. For example, No. 1 is almost a straight line up to the breaking point. No. 37 shows a very slight deviation from the straight line. A curve showing a greater deviation is that in No. 4, whilst the remainder of the hematite series, although showing approximately the same breaking stress, are markedly different in slope (En value) and degree of curvature. It is of interest to compare these with the curves of medium-phosphorus and foundry irons of approximately the same ultimate breaking strength. The greater degree of curvature in the hematite series is very marked. The point of departure from the approximately straight line is marked in certain curves. It is of interest to note that in numbers of cases even though quite an open scale of plotting was used in the original curves distinct traces of proportionality were found to exist up to quite high stress values. This has been considered worthy of note, and has been referred to in the tabulated values as the limit of proportionality.

TABLE II.—*Properties of Pig-Irons, including Stiffness.*

Specimen.	Tensile strength (tons per sq. in.).	Modulus of elasticity (lbs. per sq. in.).	Total area stress/stren. curve.	Perm. set.	Pig breaker's report.
Semi-cold blast ..	14.9	16.0	36.0	12.5	Very tough and strong
Foundry iron ..	17.3	17.1	22.4	9.25	Brittle and weak

* A Paper read before the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen, Mr. J. G. Pearce presiding.

† "Comparative Study of Some Properties of Pig-Iron": J. E. Hurst, Manchester Association of Engineers. FOUNDRY TRADE JOURNAL, Vol. 45, p. 337, *et seq.*

These various differences in manner of breaking as recorded by these stress-strain curves can be felt and appreciated by the sensitive observer when breaking specimens either by hand or with a hammer. They do not necessarily follow or bear a relationship to the ultimate breaking strength as is revealed by the results of a number of tests made on different pig-irons displayed in the order of their descending tensile strength in Table III. Looked at very broadly, the results in this table tend to show that the low-phosphorus irons have the higher ultimate strength values and also the higher resilience values; but there are one or two notable exceptions when looked at more minutely and taking into consideration the other properties of En value and permanent set, the absence of relationship between these and the ultimate strength properties is clear, and in a like manner the relationship between any of these properties and the chemical composition is difficult to discover.

Such results as these lead to the conclusion that the properties of these pig-irons when remelted and centrifugally cast cannot be predicted by reference to the chemical composition, and hence the truth of the belief in the existence of inherent properties. Since these determinations have been made on re-melted pig-irons, crucible melted, under the same conditions as near as could be possibly controlled, one must also conclude that the differences are the remnants of some differences in the original properties of the pig-irons which have survived remelting. In the tables of the Paper previously referred to, THE FOUNDRY TRADE JOURNAL, Vol. 45, page 338, samples Nos. 17 and 19 and 11 and 12 are specimens of very closely the same chemical composition, and show very clearly differences in all the mechanical properties measured. Samples Nos. 2 and 3, whilst showing marked differences in the various properties, show a difference in resilience value which is truly extraordinary and which would not have been anticipated from the difference in silicon content, which is the only marked difference in chemical composition. The pig-iron which showed the high-resilience value of 70.2 (No. 2) was extremely difficult to break.

TABLE III.—*Properties of Pig-Iron related to Composition.*

No.	T.C.	Si.	Mn.	P.	S.	Tensile strength (tons per sq. in.).	Mod. of elasticity (lbs. per sq. in.).	Resil. value	Perm. set.
6	3.71	0.52	0.39	0.37	0.125	25.4	17.0	28.2	6.8
7	3.16	1.32	0.32	0.18	0.05	22.6	16.8	29.8	8.8
8	3.00	0.83	0.42	0.43	0.139	25.9	17.1	29.8	8.8
9	3.49	0.83	0.59	0.59	0.105	16.8	17.5	20.6	9.5
10	3.99	0.91	0.41	0.41	0.016	20.2	16.9	21.6	15.6

In the light of these results it appears quite legitimate to conclude that the mechanical-strength properties of pig-irons can differ in a manner which cannot be predicted from the chemical composition, and that differences in mechanical-strength properties can persist on remelting. Thus the view that there are inherent or intrinsic mechanical-strength properties in pig-irons is a reality.

Causes of Variation in Properties of Pig-Irons.

Any discussion of the causes of variation in the properties of pig-irons in the absence of definite experimentally-determined knowledge and data must be mere speculation. The character of the ore and fuel burden in the blast furnace, the blast temperature, temperature of working, rate of driving and slag characteristics have all been advanced as potential causes of the differences in properties of the pig-iron. It is clear that experiment alone can determine whether any or all of these have any influence on the strength properties, and, as far as the author's knowledge goes, such experiments are still awaiting inauguration. The author hitherto has not been able to investigate the properties of pig-iron in relation to any one or all of these factors, and therefore is unable to give any indication as to whether or not these factors are in any way responsible for the differences observed. It is of importance in this connection to point out that repeated tests of successive consignments of the same brand of iron shows that the strength properties may vary, and sometimes within wide limits, and brands which have a high reputation, which has been experimentally confirmed, sometimes show inferior properties. This fact is of importance in relation to the frequently and often loosely-made statements with reference to the quality of brands of iron as, for example, cold-blast iron. It is possible to have consignments of cold-blast irons possessing definitely inferior-strength properties.

Influence of Type of Steel Scrap.

A certain amount of investigation has already been made by the author into the influence of steel-scrap additions on the properties of cast irons. The experiments are not yet sufficiently complete to enable them to be detailed here. As far as they have gone, however, certain quite interesting points are revealed. To the writer's mind, one of the most important is that the type of scrap appears to have an influence on the character of the strength properties. This statement is based on a number of observations showing a repeated difference in strength properties according to whether mild steel or high-carbon steel (above 0.45 per cent.) scrap was used. It is also possible that the character of the steel scrap, whether small or large and the amount, has a decided influence on the properties. Certain forms of steel scrap appear to have the effect of increasing the En value and yielding resilience curves of a straighter character with less curvature, indicating less plastic deformation in breaking. All the results so far obtained clearly point to the fact that the uncontrolled use of steel scrap in pig-iron manufacture can be responsible for low inherent-strength properties, and *vice versa*, the controlled use of scrap may be very valuable in obtained predetermined-strength properties.

Tests on Roll Irons.

Whilst the experimental work briefly described clearly establishes the reality of the existence of some inherent mechanical strength properties and discloses the nature of these properties, it might be asked justifiably what is the general value of this knowledge in the absence of any detailed knowledge as to the cause of these inherent properties, and thus the ability to control them. One aspect of the value of this knowledge will be made apparent by the following investigations on roll irons as used for the manufacture of chilled rolls. It is well known probably that manufacturers of chilled rolls, through accumulated experience, have ascertained that certain classes of irons give them satisfactory results in the manufacture of these rolls in accordance with their existing methods. The classes of irons most commonly used in chilled roll manufacture are those belonging to the well-known cold-blast and charcoal-iron types. The analyses and complete mechanical properties, together with the chilling and hardness properties of a few well-known brands of cold-blast and charcoal irons, are given in Table IV. The specimens used in these experiments were the standard form of chill test-bars as used by the leading chilled-roll manufacturers. The chill depth, mottled depth, type of chill and type of grey back were measured and described in the manner usual amongst chilled-roll manufacturers. The hardness values on the chilled surface were determined by the scleroscope, the standard Brinell method, using a 10-mm. ball and a 3,000-kg. load, and the Firth hardometer using the diamond inclinater with a 30-kg. load. The chemical analyses were made on drillings taken from standard sand-cast round bars cast at the same time as its corresponding chill test and the determination of the mechanical properties were made from ring-form specimens machined from the sand-cast bars. The sand-cast bars were cast in green-sand moulds and each specimen of iron was melted in a plumbago crucible in a Morgan-type coke-fired crucible steel-melting furnace. In each case precautions were taken to keep the melting temperature and casting temperature as near uniform as possible. The whole of the properties show variations and some are rather curious in character, as for example the very small chill depth in the sample of charcoal iron. The strength properties show some differences, the character of which will be noted. It is of interest to compare the properties of these irons with those of an ordinary refined iron of a similar silicon and phosphorus content. Confining attention to the mechanical properties one finds that, excepting the Dudley brand, the tensile strength of the refined iron is lower. In a like manner the resilience value, the permanent set value and the modulus of elasticity are lower than in the brands of cold-blast and charcoal irons. The type of stress-deflection curve obtained is described as a " poor curve " because it possessed no semblance of a limit of proportionality and very little curvature in the upper stress ranges. The comparison of the chill depth and fracture types will be noted also.

In view of this difference between the ordinary refined irons and the cold-blast and charcoal irons in spite of their similarity in chemical composition, it was decided that it would be worth while endeavouring to carry the experiments further to ascertain if it would be possible to match the properties of cold-blast and charcoal irons. It was felt that if an iron of the same composition as these latter could be obtained in which all the properties of modulus of elasticity, resilience value, limit of proportionality, permanent set, character of stress/strain curve, in addition to the ultimate tensile strength, were of the same order of magnitude of those of the cold-blast type of irons, then such an iron might be expected to behave in practice in the roll foundry in the same manner. From a wide study and collection of these various properties on all types of pig-irons and various types of pig-iron and scrap mixtures it was likewise felt that it should be possible to secure this object of matching the cold-blast type of iron by mixing together those materials of suitable compositions whose properties as a whole were either singly or as a whole of the suitable order of magnitude. In this, of course, reliance is placed upon the differences in properties being retained after remelting and blending. The results of some such blended refined-irons are given in the Table. Item 7 will be seen to be a distinct improvement on the ordinary refined iron, whilst items 8 and 9 casts of blended all-mine casts are quite equal in every respect to the properties of the cold-blast and charcoal series. A careful consideration of the rest of the properties in reference to the rest of the composition by those experienced in these will show that they likewise have changed to those characteristic of the cold-blast type. These particular experiments were carried a little further by comparing the properties of the charcoal iron plus roll scrap with the refined-iron substitute and the blended all-mine plus scrap. The results obtained are indicated in the last three items

of the Table. They serve to show that the properties of these irons can be substantially maintained when used under conditions comparable with those used in roll-making practice.

The results given of this experiment amply demonstrate that the knowledge of the attributes of the strength properties of iron can be applied successfully to the duplication or matching of some of the inherent mechanical properties, particularly those of toughness, of cold-blast and charcoal pig-irons. In this respect they demonstrate the value of work of this type, for facility in matching pig-irons is a matter of definite industrial importance.

Vote of Thanks.

In proposing a vote of thanks to the lecturer, MR. E. J. LEWIS said they had to thank Mr. Hurst for a most interesting and instructive Paper, and one which every practical foundryman could easily follow. Almost everyone had simple form of shock or impact test, but he (Mr. Pearce) did not consider that a single blow impact test was a fair test of cast iron, and considered the repeated impact test was much to be preferred. A high resilience value would be expected, not merely with a high tensile strength, but with a low tensile strength, as the latter would be expected to have greater elongation, which is the measure of ductility.

Repeated Impact as Discriminatory Test.

Referring again to the repeated impact test for cast iron, Mr. Pearce said that whereas the commercial range of tensile strengths on grey iron was usually only between 10 to 22 tons, the range obtained in the repeated impact test was 200 to 8,000 blows. The repeated impact test showed up very clearly slight differences in the quality of an iron. The elongation of a test-bar did not show up these slight differences, and was found to vary very little between fracture was fast dying. Could the lecturer explain what caused the differences in fractures of pigs of similar composition?

AUTHOR'S REPLY.

MR. HURST, in replying, said he was pleased to note that everyone seemed to agree that there was such a thing as inherent properties in pig-iron. Replying to Mr. Hall, he said that it might be more correct to say that chemical analysis, as ordinarily expressed, did not account for differences in properties. Other factors, for example, occluded gases, might be analysed for but would not give any indications as to their effect, but experiments on these lines would be very interesting.

In answer to Mr. Callaghan, he agreed that the addition of steel had an influence on the iron, and also the quality and character of the steel added would have an influence on the effect experienced. While 5 to 10 per cent. of steel

TABLE IV.—*Properties of Pig-Irons as Ascertained by Chill and other Tests.*

	Pig-iron.	Composition.					Chill test details.							Mechanical Properties.						
		Total carbon.	Si.	Mn.	S.	P.	Chill depth.	Chill type.	Scler.	Brinn.	Firth.	Mottle depth.	Type back.	Tens. Tons/sq. in.	Mod. rupture.	En value.	Resil.	Limit propty.	Perm. set.	Type of curve.
1	Valley	3.71	0.52	0.39	0.125	0.37	¾ in.	Bright	63	465	522	1½ in.	Med. open grey air chill	25.4	40.5	17.0	28.2	12.0	6.8	Good
2	Swedish	3.16	1.32	0.28	0.050	0.18	⅛ in.	Dull	58/60	440	488	⅜ in.	Close grey	22.6	36.2	16.8	29.8	13.0	8.8	Good
3	Grazebrook	3.00	0.83	0.42	0.139	0.43	⅛ in.	Norm.	60	420	460	1½ in.	Close grey	25.9	41.5	17.1	29.8	13.0	8.8	Good
4	Dudleys	3.49	0.83	0.59	0.105	0.48	5/16 in.	Med. bright	60	433	481	¾ in.	Med. open grey	16.8	26.7	17.5	20.6	—	9.5	Poor
5	Charcoal	3.99	0.91	0.41	0.016	0.16	Trace	Bright	—	221	237	nil	Very open grey	20.2	32.2	16.9	21.6	—	15.6	Moder.
6	Ordinary refined No. 8070	3.11	0.75	0.30	0.071	0.39	⅛ in.	Norm.	58/60	400	428	1 in.	Close grey	18.6	29.8	16.6	15.5	—	2.5	Poor
7	Refined iron substitute 7B/9	3.43	0.87	0.54	0.096	0.42	5/16 in.	Dull	60/65	465	526	⅞ in.	Medium grey	19.6	31.4	17.9	20.8	12.0	5.4	Good
8	Blended all-mine refined 6B/2	3.71	1.12	0.41	0.068	0.49	¼ in.	Bright	55/60	480	551	nil	Open grey	26.8	43.0	17.8	30.8	14.0	7.5	Good
9	Blended all-mine refined 8411	3.82	0.66	0.45	0.08	0.44	¼ in.	Very bright	70	495	575	⅜ in.	Open grey	25.9	41.5	18.0	29.75	14.0	12.4	Good
10	No. 5 charcoal with 60 per cent. roll scrap	3.00	0.66	0.25	0.110	0.35	1 in.	Med. bright	60	440	488	1 1/16 in.	Close grey air chill	25.9	41.5	17.2	25.4	—	14.8	Moder.
11	No. 7 refined iron substitute, 7B/9 with 33 per cent. roll scrap	3.11	0.69	0.47	0.128	0.37	1 in.	Dull	50/55	440	479	2 in.	Med. grey air chill	20.1	32.2	18.0	19.5	12.0	6.6	Good
12	Blended all-mine 6B/2 50 per cent. roll scrap	3.27	0.79	0.35	0.126	0.45	1 in.	Dull	60/62	470	510	2⅜ in.	Close grey air chill	25.8	41.3	18.1	31.5	14.0	7.8	Good

experienced the trouble when, after working with the same iron for months, difficulties would suddenly crop up, castings would be spoiled and no change could be found in the analysis of the iron. This was no doubt to be explained by some change in the inherent properties of the pig-iron used, due to some change in the method of production. If some means of testing an iron could be devised to ensure that its properties had not changed from that used previously, it would be a great step forward.

MR. T. R. TWIGGER, in seconding the vote of thanks, said that he was a great admirer of the work done by Mr. Hurst, who, by his scientific Papers and writings, could be said to have put the foundry industry on the map and brought it to the notice of the engineers. He considered that this was of great value to the status of the trade.

DISCUSSION.

MR. J. G. PEARCE, the chairman, in opening the discussion, said that there were, without question, differences in pig-iron which could not be explained by analysis. In carrying out his tests, Mr. Hurst had kept his melting conditions constant. The British Cast Iron Research Association had proved that irons of the same composition could have very different physical properties, and this was entirely controlled by the melting conditions. Referring to the lecturer's mention of the hammer blow as a common test of cast iron in the shops, this was really a different irons. He thought that it would not be long now before these differences would be thrashed out and the inherent properties of cold-blast iron, refined iron, all-mine iron, etc., would be explained.

MR. H. G. HALL remarked that, speaking as a chemist, he agreed that irons could have inherent properties, but he could not agree that analysis would not probably show the true cause, as he considered that the analysis of gases occluded in the metal might have a great bearing on these differences in properties. It was well known, for example, that oxygen in copper altered the resilience properties considerably and also persisted on melting.

Influence of Steel Additions.

MR. G. M. CALLAGHAN stated that he felt from practical experience that there were differences in irons which were due to inherent properties. The introduction of steel into a cast iron gave it properties which were not revealed by analysis. Ten per cent. of steel, for example, made little difference in the analysis, but certain phenomena would be revealed. He found that rougher castings were obtained in green sand when 5 per cent. of steel was added to the charge. The iron had a different look at the cupola spout and showed a greater hardness when cast into a ½-in. dia. bar.

MR. G. W. BROWN remarked that he thought that the practice of judging pig-iron from might not have an effect on the simple properties, it would make a difference to such properties as the En value.

Early Experiments on Elongation.

Mr. Brown's question regarding the differences in fracture of pig-iron of the same composition brought up the question of whether it was possible to obtain different brands of pig-iron of the same composition. A difference of fracture was in itself a difference in a certain property. The main difficulty in differentiating between two irons was that the deflections and permanent sets were of very small magnitude, and this necessitated using machined bars. Early engineers had cast bars 10 ft. long and pulled these in tensile to obtain the elongation, but even then the values obtained were very small. The results obtained from resilience tests were very similar to those obtained from impact tests. He would like to see tests carried out by breaking bars in transverse and measuring the watts of energy consumed in fracturing the bars. He did not agree that low tensile strength would necessarily show a high resilience value due to high plasticity, as it was possible to have high resilience with high tensile strength. He would like to stress again the value of studies of this nature, as when it is possible to assess the value and cause of properties possessed by certain irons it will be possible to match these irons.

XUM

This Week's News in Brief.

Trade Talk.

THE DAVIDSON METAL COMPANY, LIMITED, is being wound up voluntarily. The liquidator is Mr. H. G. Warren, King William Street House, London, E.C.4.

THE RIDDINGS (DERBYSHIRE) IRONWORKS of the Stanton Ironworks Company, Limited, were re-opened recently after having been closed since March last.

MESSRS. H. W. LINDOP & SON, malleable-iron founders, of Pleck Road, Walsall, are extending their premises by the addition of a shop to accommodate new melting plant.

A NEW COMPANY called the International Meehanite Metal Company, Limited, 14-16, Church Street, London, N.1, has been formed, with Mr. E. H. Jones and Mr. O. Smalley as directors.

THE HEATLY-GRESHAM ENGINEERING COMPANY, LIMITED, have informed us that, as from August 1, they will operate from the Craven Ironworks, Ordsall Lane, Salford, 5, Manchester, instead of from the Gresham Ironworks, Letchworth, Herts.

BLAST-FURNACEMEN AT THE North-East Coast ironworks are to benefit as the result of the temporary agreement reached with ironmasters, whereby base rates will be increased by 2½ per cent. during the next quarter. The advance takes effect from Sunday last.

OWING TO THE SPEEDING-UP of the erection of houses for completion by the autumn of this year in order to qualify for the appropriate Government subsidy, there has followed an increased demand for light castings. Foundries are now more fully employed in the Falkirk district than they have been for some considerable period.

MOST OF THE WORKS in Glasgow and West of Scotland district which closed for the annual summer holiday on July 13 reopened on July 24, but in a few cases the resumption was delayed for a few days. Works in Edinburgh and East of Scotland district closed for holidays on July 21, and the general resumption will take place on August 1.

THERE WAS A CONSIDERABLE IMPROVEMENT in the iron and steel output of Czecho-Slovakia in May, compared with April last and May, 1932. The pig-iron output in May was 48,381 metric tons, against 41,000 tons in April and 33,000 tons in May, 1932. The output of crude steel was 85,872 tons, compared with 66,000 tons in April and 55,000 tons in May, 1932. The cause of this unexpected improvement was an increased seasonal demand in the home market.

THE PROPOSAL OF THE Hull City Council to purchase Earle's Shipyard, one of the yards closed as redundant by National Shipbuilders' Security, Limited, is being abandoned. A special committee of the Corporation appointed to conduct negotiations for the purchase met last week and decided to report that no useful purpose would be served by continuing negotiations, especially as machinery at the yard has since been sold. They recommend that no further action be taken.

THE Import Duties (Exemptions) (No. 7) Order and the Additional Import Duties (No. 14) Order, 1933, issued by the Treasury, implement the trade agreements with Norway and Sweden. The first order exempts from the general *ad valorem* duty charcoal-smelted pig-iron, ingots, blooms and billets thereof, ferro-manganese, silico-manganese, and other products; and the second reduces the duties on iron and steel ingots, bars, rods, shapes, etc. Both orders came into force on July 7.

WITH THE CESSATION OF WORK by Messrs. Cox & Danks, Limited, who have salvaged nearly 250,000 tons of the scuttled German fleet from the deep waters of Scapa Flow, there are still thirteen capital warships on the bed of the sea. The task of raising the remainder, it is understood, is to be undertaken by Metal Industries, Limited. Metal Industries, Limited, have broken up, at Rosyth, the ships which have been salvaged by Messrs. Cox & Danks, and are now to undertake the dual task of salvaging and breaking up. It is learned that the firm have purchased the plant-lifting material and boats used by Messrs. Cox & Danks, at Stromness. It is estimated that the amount of naval shipping still beneath the surface is nearly 200,000 tons.

AT THE RECENT ANNUAL MEETING of the Barrow Hematite Steel Company, Limited, it was announced that the company had lined two of its open-hearth furnaces with basic linings and was now able to supply basic as well as acid open-hearth steel. In the hoop department the range of manufactures had lately been extended, particularly in materials for the motor industry. In recent months the company had added to its products phosphoric foundry pig, thereby opening up new markets. The chairman stated that but for orders from British railways their rail trade last year could have been described as non-existent. For months there was not so much as a reminder of an order for a foreign or colonial railway. He now detected signs of improvement in the steel trade.

A GENERAL MEETING was held in London on Tuesday of the 4½ per cent. guaranteed debenture stockholders of the Stanton Ironworks Company, Limited, when an extraordinary resolution was agreed to modifying provisions in the trust deed. The new clauses provide that: The voting power at a general meeting of stockholders shall be one vote for every £1 of stock; the unguaranteed debenture stock shall not be repayable earlier than the date appointed for the redemption of the guaranteed debenture stock as the company shall determine; and power shall be reserved after the guaranteed debenture stock has been redeemed to create and issue not exceeding £1,000,000 additional unguaranteed debenture stock ranking *pari passu* with the unguaranteed debenture stock referred to in the trust deed.

MOVING THE ADOPTION of the report and balance sheet at the 23rd annual meeting of the Sheffield Exchange (coal, iron, steel and allied trades), held on July 7, Mr. Joseph Ward, the President, referred to the fact that twelve months ago the hope was expressed that 1932-33 would see a general revival in trade. Although that revival had not developed to the extent hoped for, there were, nevertheless, unmistakable signs that the revival would grow and expand throughout 1933-34. Industry generally, he said, had experienced a year of great difficulty, and it had not received much encouragement. It was his belief, however, that a genuine effort had been made to find a solution to their many difficulties. Mr. S. Guy Newton moved the re-election of Mr. Joseph Ward as President for the seventh successive year. The vacancy on the committee caused by the death of Mr. J. K. McMinn was filled by the election of Mr. J. W. S. Judge.

Company Reports.

Mather & Platt, Limited.—Interim dividend on the ordinary shares of 2½ per cent.

Steel Company of Canada, Limited.—Second quarterly dividend of 30 cents per share on the common stock.

Harland & Wolff, Limited.—Trading loss for the year 1932 was £118,178. After crediting interest on investments, income-tax refund and £100,000 from reserve, there is a credit balance carried forward of £47,058.

W. & T. Avery, Limited.—Balance at credit of profit and loss account for year ended March 31, including £54,798 brought in, £150,310; dividend on the ordinary shares of 10 per cent., less tax, making 15 per cent. for the year; carried forward, after payment of dividends on "A" and "B" preference shares, £59,124.

Head, Wrightson & Company, Limited.—Accounts for year to April 30 last show that a balance of £604 was brought in, and £27,000 was transferred from general reserve. After deducting loss for the year, before charging depreciation, £19,748, interest on debentures and directors' fees, a sum of £355 is carried forward.

Report on Routine Methods for Testing Green Sands.

(*Continued from page* 52.)

Restoring the bond of floor sand by the addition of proprietary or special binders is receiving increased consideration. Such investigation can only be followed successfully if simple and rapid methods of testing bond strength, etc., are available.

Sand testing is at present only in its infancy in this country, but there is little doubt that there is a great future for it and that in a few years the great majority of founders who wish to keep abreast of the times will adopt it.

(*To be continued.*)

Personal.

MR. ROBERT KIDSTON, assistant electrical engineer to Carron Company, Falkirk, has been awarded by the Association of Mining Electrical Engineers the premier award for the best Paper submitted during the year, entitled "The Reconditioning of Electrical Apparatus."

MR. T. D. MORGAN, M.I.Mech.E., has been appointed as agent for Wild-Barfield Electric Furnaces, Limited, and G.W.B. Electric Furnaces, Limited, for South Wales and the West of England. Mr. Morgan's address is: "Glaisdale," Porthcawl, Glam. The telephone number is Porthcawl 30.

ON THE OCCASION of his marriage, on July 14, Mr. James B. Cowan, works manager of the Motherwell Bridge & Engineering Company, Limited, was made the recipient of gifts at a social gathering of the workers on July 7. Mr. W. J. Coughtrie, foreman engineer, presided, and Mr. John Moffat handed over a crystal table lamp and silver salver to Mr. Cowan as a token of the good wishes of the workers.

MR. P. J. FENWICK has just retired from the position of purchasing agent to the Stanton Ironworks Company, Limited, on the completion of 21 years' service. He was formerly certificated manager at the Pleasley Colliery of the company. On June 30 he was entertained to a dinner by the managing director, Mr. E. J. Fox, and his colleagues, and received a presentation.

MR. HORACE BROADBENT, chairman and managing director of Messrs. Thomas Broadbent & Sons, Limited, engineers, Central Ironworks, Huddersfield, received presentations from the directors and staff of the company on July 1, to commemorate his 70th birthday and 55 years' service with the firm. His fellow-directors presented him with a souvenir album, portraying the history of the firm since its commencement in 1864.

MR. HENRY WILSON, Edinburgh, has been awarded a Whitworth Scholarship of £150. He was formerly a student at Heriot Watt College, Edinburgh, and passed through the summer course for apprentices in 1930 and 1931, securing second place, and at the same time gained a Lloyd scholarship of £100 for three years awarded by the Institute of Marine Engineers. Mr. Wilson served an apprenticeship in engineering with Messrs. Ramage & Ferguson, Limited, Leith.

MR. TOM S. PEACOCK, managing director, has been appointed deputy-chairman of Messrs. Guest, Keen & Nettlefolds, Limited, in succession to the late Mr. F. W. Keen. MR. CHARLES H. KEEN and MR. KENNETH S. PEACOCK have been elected to seats on the board. Mr. T. S. Peacock is chairman of Messrs. Bayliss, Jones & Bayliss, Limited, British Screw Company, Limited, F. W. Cotterill, Limited, John Garrington & Sons, Limited, New Cransley Iron & Steel Company, Limited, Tolley, Son & Bostock, Limited, and the United Wire Works (Birmingham), Limited. He is also a director of John Lysaght, Limited, Recess Screws (1927), Limited, Singleton & Cole, Limited, and Tarmac (South Wales), Limited. Mr. C. H. Keen is managing director of Messrs. Guest, Keen & Piggotts.

Wills.

RICHARDSON, ANDREW, retired engineer, Greenock £9,221

Obituary.

MR. JOSEPH KENT SMITH, a former metallurgical consultant in Sheffield, has died in Detroit, Michigan.

MR. WALTER NEWTON, who retired a few months ago from the shipbreaking yard of Messrs. P. & W. M'Lellan, Limited, at Bo'ness, after many years' service, died on July 20 at his home at Bo'ness after a short illness.

MR. CHARLES HYDE, who was secretary of Messrs. Robert Stephenson & Company, Limited, locomotive builders, of Darlington, for many years, retiring in December, 1929, has died at his home, West Thornfield, Carmel Road, Darlington, at the age of 64.

MR. WILLIAM E. CLELAND, director and general manager of the Sheffield Testing Works, Limited, testing engineers and analytical chemists, died suddenly last week. Mr. Cleland was born at Coatbridge in 1862, and had been manager of the Sheffield Testing Works since 1889. He was a member of the Institution of Mechanical Engineers, the Iron and Steel Institute, the Institute of Metals, and the American Society for the Testing of Materials.

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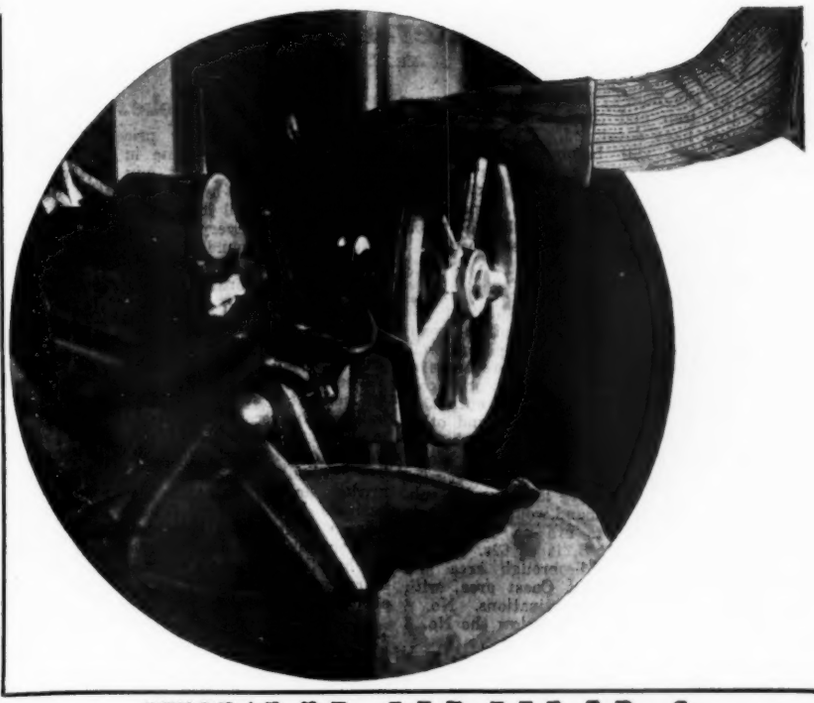

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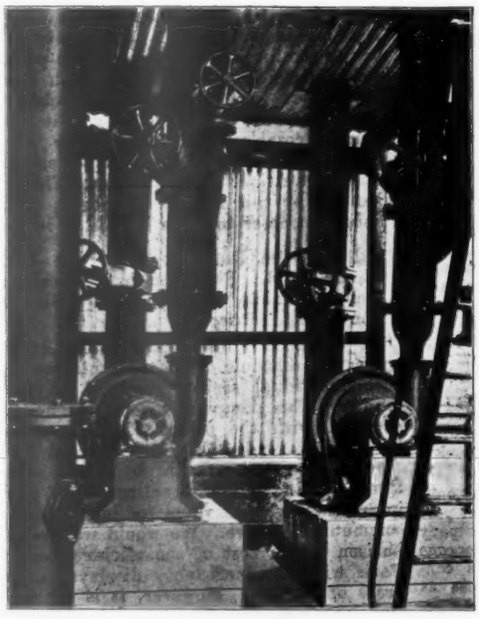

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Raw Material Markets.

The effects of the holiday season are now more apparent in the iron and steel trade and rather quieter conditions have developed. With August at hand, this tendency will become more marked. Prospects for the autumn are regarded favourably. Business in pig-iron during the past week, on the whole, has been well maintained. The demand for semi-finished steel is upheld, and a moderately good business continues to be done in finished steel.

Pig-Iron.

MIDDLESBROUGH.—For the time of the year, the Cleveland pig-iron trade is holding up very well. The demand is maintained, and there are signs of expansion in some directions. The steelworks continue to take a large proportion of the output of pig-iron, and the demand from foundries and other consuming works is sufficient to absorb the remainder, with occasional withdrawals from stock. Stocks of Cleveland iron, though providing a reasonable working margin, are not very large, and a substantial improvement in the demand would necessitate an increase in output. There are no changes in prices to record. No. 3 G.M.B. is at 62s. 6d. per ton for delivery in the Middlesbrough area and 64s. 6d. for delivery North-East Coast area, with unaltered differences for other destinations. No. 4 forge and No. 4 foundry are at 1s. below the No. 3 price, and No. 1 foundry is 2s. 6d. above No. 3.

There is renewed talk of an agreement among East Coast hematite makers with regard to prices, which meanwhile are firm at 59s. for mixed numbers and 59s. 6d. for No. 1. Good sales continue to be reported, but, in the aggregate, there are still considerable stocks, although the position in this respect varies considerably between the different works.

LANCASHIRE.—The light-castings makers in this area continue to be fairly busy, and are taking fair quantities of pig-iron. Other trades show little or no increase in requirements, but deliveries of iron to works on the whole are maintained. During the past week or so consumers have been showing more interest in forward buying, having, apparently, some doubt as to the continuance of present price levels, and assuming that any change will be in an upward direction. Offers of scrap iron continue to be plentiful, good textile-machinery scrap being quoted at between 32s. 6d. and 37s. 6d. per ton, according to delivery.

MIDLANDS.—The tone of the pig-iron market in this area is still good. In spite of the holiday season there has been little slowing-down in the rate at which iron is going into consumption. New business at the moment is not on a large scale, but it has to be remembered that many of the bigger consumers of pig-iron in the South Staffordshire area are already covered for some months ahead. There is to be a meeting of the Central Pig-Iron Producers' Association this week, but it is not expected that any changes in prices will be made. Meanwhile, current rates are 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, Lincolnshire and Staffordshire No. 3, including delivery to Birmingham and Black Country stations. Forge iron for puddling is quoted at 5s. less, but forge iron for foundry use is 4s. below the No. 3 foundry level. Cleveland is obtainable at the same price as Derbyshire No. 3. Buying of hematite iron is in moderate quantities only, prices being unchanged at 84s. 6d. for West Coast No. 3 or mixed numbers, and from 74s. 6d. to 77s. 6d., delivered, according to tonnage and quality, for Welsh or East Coast hematite. With regard to special qualities of pig-iron, medium-phosphorus irons are quoted from 70s. to 85s., the latter figure being the Scottish price for their No. 3 grade. Low-phosphorus irons are offered from 80s. to 90s., with refined pig at £5 to £6 15s. delivered.

SCOTLAND.—There will be little activity in the Glasgow area until the beginning of next week, when the holidays will be over. This week business has been at a standstill, all the works being closed. The light-castings industry in the Falkirk area is operating, and has fairly good prospects. The light foundries have to pay 62s. 3d. f.o.t. Falkirk district for Middlesbrough No. 3 iron and 65s. 3d. f.o.t. Glasgow area, but they are not anxious buyers at these figures, arguing that there is no advantage to be gained in purchasing more than their current requirements as they arise. Prices of Scottish iron are unchanged at the official figure of 65s. per ton for No. 3, with 2s. 6d. extra for No. 1. Export quotations, f.o.b. Glasgow, are:—No. 3, 67s. 6d.; No. 1, 70s. per ton.

Coke.

Suggestions of higher prices for foundry coke, based on the strong tone in the export markets, have not brought about any better demand from inland users, who are content still to confine their purchases to small lots to meet immediate requirements. For delivery in Birmingham and district, best Durham foundry coke is quoted at from 36s. to 38s., Scottish low-ash coke at 39s. to 40s., and Welsh coke, according to analysis, at from 30s. to 45s. per ton.

Steel.

There has been some business in Continental semi-finished steel at exceptionally low prices, but the bulk of the recent business has gone to the British producers. Most of the latter are well off for orders for this class of material, and the demand seems to be gradually expanding. In the finished-steel market, holiday influences are more noticeable, and business has declined. There is, however, a fair volume of inquiries in circulation. The recent reduction in some descriptions of Continental steel has had little effect on the market. Export business is rather quiet, partly as a result of fluctuating exchanges and partly owing to seasonal influences.

Scrap.

In most areas there is a steady demand for scrap iron, although steel is the strongest feature of the markets. In the Middlesbrough area the market for heavy or machinery cast-iron scrap is somewhat slow at the moment, and prices are unaltered at 39s. and 41s. per ton respectively. There is rather more inquiry for light castings and the works are taking better deliveries, the current quotation being round about 36s. In South Wales also heavy cast iron in large pieces and furnace sizes is still rather quiet, and prices are unchanged at 43s. to 44s. Light cast iron has a better inquiry at 38s. Good cast-iron machinery scrap for foundry purposes has a restricted demand at 48s. to 50s. In the Midlands there is a steady demand from the local ironfounders for cast-iron scrap, and prices are firm; for selected heavy machinery metal in handy sizes up to 47s. 6d. is offered, 45s. for heavy pipe and plate scrap and 37s. 6d. to 40s. for clean light cast iron, all delivered works. In Scotland, where deliveries are affected by the holidays, heavy machinery cast-iron scrap in pieces not exceeding 1 cwt. is at around 48s. 6d., with ordinary cast iron to the same specification firm at 45s. per ton, as there is not much of this material available at present. Old cast-iron railway chairs are not plentiful and the price is 48s. 6d. to 50s., with light metal at 37s. 6d., all delivered works.

Metals.

Copper.—The market has been somewhat irregular, largely because of the unsettled conditions of the monetary exchanges. Consumers have not taken much interest in the market, being inclined to await developments. Consumption, however, is on a fair scale, and it is unlikely that prices will go to a much lower level; while, on the other hand, in view of the large stocks in the United States, a movement very far in the other direction is also improbable.

The week's prices have been as follows:—

Cash.—Thursday, £38 5s. to £38 6s. 3d.; Friday, £37 8s. 9d. to £37 10s.; Monday, £36 15s. to £36 16s. 3d.; Tuesday, £37 3s. 9d. to £37 5s.; Wednesday, £37 1s. 3d. to £37 2s. 6d.

Three Months. — Thursday, £38 10s. to £38 11s. 3d.; Friday, £37 11s. 3d. to £37 12s. 6d.; Monday, £36 17s. 6d. to £36 18s. 9d.; Tuesday, £37 6s. 3d. to £37 7s 6d.; Wednesday, £37 3s. 9d. to £37 5s.

Tin.—Business with consumers has been only moderate, rather quieter conditions for the most part being reported. Messrs. Rudolf Wolff & Company report that market conditions have not undergone any very material change; price movements continue to be governed by the same influences as previously reported, a certain amount of unsettlement being created by the fluctuation of the dollar exchange, the uncertainty still surrounding the general situation in the United States, and by varying reports connected with the liquidation of stocks by pool interests. The market in these circumstances displays a sensitive condition. There is no disposition unduly to depress values, and at the lower levels a good deal of resistance is met, but at the same time, while the outlook is so uncertain, buyers are cautious, for higher prices in turn occasion some liquidation. In the near future, therefore, it would seem that irregular movements are likely to continue.

Daily quotations:—

Cash.—Thursday, £212 15s. to £213; Friday, £212 15s. to £213; Monday, £213 2s. 6d. to £213 5s.; Tuesday, £215 15s. to £215 17s. 6d.; Wednesday, £214 15s. to £215.

Three Months.—Thursday, £212 10s. to £212 15s.; Friday, £212 15s. to £212 17s. 6d.; Monday, £213 2s. 6d. to £213 5s.; Tuesday, £215 15s. to £215 17s. 6d.; Wednesday, £214 15s. to £215.

Spelter.—This metal has been irregular, but has not lost much on balance. Business with consumers in this country has slackened a little, the uncertain tendency of the market for the time being having caused buyers to adopt a cautious attitude. On the Continent, the market remains steady, and though trade demand has been light, a firm undertone has been imparted by the improving statistical position. In the United States of America, steady conditions are reported.

Price fluctuations:—

Ordinary.—Thursday, £17 16s. 3d.; Friday, £17 12s. 6d.; Monday, £17 7s. 6d.; Tuesday, £17 15s.; Wednesday, £17 7s. 6d.

Lead.—Dull conditions continue to be seen in connection with this metal. Consumption, while on a fairly steady basis, is not particularly good at the moment; it should, however, show an improvement once the holiday season is out of the way. On the whole, prospects are not regarded as unfavourable, and the undertone remains steady.

Daily market prices:—

Soft Foreign (Prompt).—Thursday, £13 10s.; Friday, £13 7s. 6d.; Monday, £13 1s. 3d.; Tuesday, £13 7s. 6d.; Wednesday, £13 5s.

Publications Received.

British Engine, Boiler & Electrical Insurance Company, Limited, Technical Report for 1932.—Published from 24, Fennel Street, Manchester 4. Price 7s. 6d.

We always look forward with interest to the receipt of this annual publication, as it invariably throws new light on metallurgical and engineering problems from the coroner's point of view. This year cast iron has come out with flying colours, if one can believe the adage that "No news is good news." Welding is still very much to the fore, and we know of no publication which judges its potentialities with less bias. It publishes some excellent researches undertaken by Mr. L. W. Schuster, and it condemns in unequivocable terms the shoddy workmanship the company's engineers have encountered in their investigations of failures. The attitude taken up by this Report is, indeed, of a most helpful character to those interested in welding.

Riddle of the Rates, by W. IVOR JENNINGS, M.A., LL.B. Published by "Local Government Chronicle," 227-239, Tooley Street, London, S.E.1. Price 1s.

At the back of our local rate-demand form there is a schedule of the amounts required for each individual service rendered to the community. This pamphlet converts each item into a story, with the object of, apparently, convincing the reader that he gets good value for money. He opens with a small chapter on "maintaining public cleanliness." We are not impressed with the value for money that many communities derive. We would welcome a comparison of the cost of the efficient cleansing of Paris with the inefficiency displayed in certain areas of London. However, it is the object of the author to put these factors in their most favourable light, and undoubtedly he has succeeded. We still remain convinced, however, that many communities give very poor value for money.

JAS. GRAY & SONS, *Enamelling Engineers,*

Telegrams: "Grayasons, Sowest, London."

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Telephone: VICTORIA 5794.

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ESCOL ENAMELS MEET EVERY REQUIREMENT.

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ESCOL ENAMELS ENABLE THE PRODUCTION OF HIGHEST QUALITY WARE TO BE OBTAINED WITH A MINIMUM OF OXIDES AND OPACIFIERS.

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ESCOL ENAMELS ARE APPLIED DIRECT TO THE IRON, ENABLING HIGH QUALITY FINISHES TO BE OBTAINED ON THE MOST ECONOMICAL BASIS.

PORCELAIN ENAMELS
FOR
CAST IRON AND SHEET METAL.

If you are considering the enamelling of your product—If you are at present engaged in enamelling—
WE CAN BE OF ASSISTANCE TO YOU.

Manufacturers: J. F. Stewart & Co., Ltd., Paisley Works, London, E.15.

CAST IRON FLANGED PIPES
2 in.—12 in. & CONNECTIONS. to 24 in. dia.

WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.

JAMES & RONALD RITCHIE, LTD.,

Telephone: 3852 (2 Lines). MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

RAW MATERIALS—PRICE LIST.

(Wednesday, July 26, 1933.)

COPPER.

	£	s.	d.
Standard cash	37	1	3
Three months	37	3	9
Electrolytic	41	0	0
Tough	39	5	0
Best selected	39	15	0
Sheets	68	0	0
India	49	10	0
Wire bars	41	10	0
Ingot bars	41	10	0
H.C. wire rods	43	10	0
Off. av. cash, June	36	16	1 3/16
Do., 3 mths., June	37	0	0 1/8
Do., Sttlmnt., June	36	16	3 1/4
Do., Electro, June	41	8	9 1/8
Do., B.S., June	40	3	0 3/8
Do., wire bars, June	41	17	7 3/8
Solid drawn tubes			10½d.
Brazed tubes			10½d.
Wire			7d.

BRASS.

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	8¾d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	8d.
Wire	8d.
Rolled metal	7½d.
Yellow metal rods	4¾d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN.

	£	s.	d.
Standard cash	214	15	0
Three months	214	15	0
English	215	10	0
Bars	216	15	0
Straits (nom.)	219	15	0
Australian (nom.)	—		
Eastern	219	15	0
Banca (nom.)	219	15	0
Off. av. cash, June	220	1	8
Do., 3 mths., June	219	15	7 9/16
Do., Sttlmt., June	220	2	1 1/16

SPELTER.

	£	s.	d.
Ordinary	17	7	6
Remelted	17	15	0
Hard	15	5	0
Electro 99.9	19	15	0
English	18	2	6
India	17	10	0
Zinc dust	20	0	0
Zinc ashes	4	5	0
Off. aver., June	16	17	7 3/8
Aver. spot, June	16	19	9 1/16

LEAD.

	£	s.	d.
Soft foreign ppt.	13	5	0
Empire	13	12	6
English	14	15	0
Off. average, June	13	8	6½
Average spot, June	13	5	7 7/16

ALUMINIUM.

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	26	0	0
Do., V.M. ex-whse.	25	10	0
Rods	30	10	0

ANTIMONY.

	£	s.	d.	£	s.	d.
English	37	10	0 to	40	0	0
Chinese				26	15	0
Crude					—	

QUICKSILVER.

	£	s.	d.	£	s.	d.
Quicksilver	8	7	6 to	9	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£6 10 0
45/50%	£12 10 0
75%	£18 2 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	5/6 per lb.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£15 0 0
Ferro-tungsten—	
80/85%	1/9 lb.
Tungsten metal powder—	
98/99%	2/- lb.
Ferro-chrome—	
2/4% car.	£25 10 0
4/6% car.	£21 17 6
6/8% car.	£19 7 6
8/10% car.	£18 17 6
Ferro-chrome—	
Max. 2% car.	£30 0 0
Max. 1% car.	£31 0 0
Max. 0.70% car.	£42 10 0
70%, carbon-free	10¾d. lb.
Nickel—99.5/100%	£225 to £230
"F" nickel shot	£202 10 0
Ferro-cobalt	5/9 lb.
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy steel				2	5	0
Bundled steel and shrngs.	1	17	6 to	2	4	0
Mixed iron and steel	2	1	0 to	2	1	6
Heavy cast iron	2	3	0 to	2	4	0
Good machinery	2	8	0 to	2	10	0
Cleveland—						
Heavy steel				2	5	0
Steel turnings				1	11	6
Cast-iron borings				1	2	0
Heavy forge				2	10	0
W.I. piling scrap				2	0	0
Cast-iron scrap	1	19	0 to	2	1	0
Midlands—						
Light cast-iron scrap	1	17	6 to	2	0	0
Heavy wrought iron				2	5	0
Steel turnings, f.o.r.				1	5	6
Scotland—						
Heavy steel	1	18	9 to	2	0	0
Ordinary cast iron				2	4	6
Engineers' turnings				1	10	6
Cast-iron borings				1	12	6
Wrought-iron piling				2	1	6
Heavy machinery				2	7	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	31	0	0
Brass	20	0	0
Lead (less usual draft)	12	10	0
Tea lead	10	0	0
Zinc	12	0	0
New aluminium cuttings	74	0	0
Brasiery copper	28	0	0
Gunmetal	26	0	0
Hollow pewter	135	0	0
Shaped black pewter	100	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	65/-
Foundry No. 3	62/6
,, at Falkirk	62/3
,, at Glasgow	65/3
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	59/6
Hematite M/Nos., f.o.t.	59/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	68/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/-
,, No. 3 fdry.	66/-
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/-
,, fdry. No. 3	66/-
,, fdry. No. 1	69/-
Scotland—	
Foundry No. 1	67/6
,, No. 3	65/-
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	80/-
Clyde, No. 3	80/-
Monkland, No. 3	80/-
Summerlee, No. 3	80/-
Eglinton, No. 3	80/-
Gartsherrie, No. 3	80/-
Shotts, No. 3	80/-

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	0	0 to	9	15	0
Nut and bolt iron	6	15	0 to	7	10	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.	13	0	0			
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.				8	5	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)			6 17	6 & up.		
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)			9 10	0 & up.		
Black sheets, 24g. (4-t. lots)				10	0	0
Galv. cor. shts. ,,				12	10	0
Galv. flat shts. ,,				13	0	0
Galv. fencing wire, 8g. plain				14	0	0
Billets, soft	5	0	0 to	5	12	6
Billets, hard	6	12	6 to	7	2	6
Sheet bars	4	15	0 to	5	5	0
Tin bars				4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	12½d.
Rods	11d.
Tubes	15½d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3⅛ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	17.34
No. 2 foundry, Valley	16.50
No. 2 foundry, Birm.	13.00
Basic	17.89
Bessemer	18.89
Malleable	18.39
Grey forge	18.39
Ferro-mang. 80%, seaboard	82.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.60
Sheets, black, No. 24	2.25
Sheets, galv., No. 24	2.85
Wire nails	2.10
Plain wire	2.10
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.25

COKE (at ovens).

Welsh foundry	20/- to 22/6
,, furnace	15/- to 15/6
Durham and Northumberland—	
,, foundry	21/- to 25/-
,, furnace	13/3
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	17/3 to 17/6
,,	28×20 ,,	34/6 to 35/-
,,	20×10 ,,	24/9 to 25/3
,,	18¾×14 ,,	18/-
C.W.	20×14 ,,	15/9 to 16/-
,,	28×20 ,,	33/-
,,	20×10 ,,	22/9
,,	18¾×14 ,,	16/6

SWEDISH CHARCOAL IRON & STEEL.

	£	s.	d.	£	s.	d.
Pig-iron	£6	0	0 to	£7	0	0
Bars-hammered, basis	£16	0	0 to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0 to	£16	0	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£30	0	0 to	£31	0	0
Faggot steel	£18	0	0 to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0 to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
July	20 ..	38	5	0	dec. 6/3
,,	21 ..	37	8	9	,, 16/3
,,	24 ..	36	15	0	,, 13/9
,,	25 ..	37	3	9	inc. 8/9
,,	26 ..	37	1	3	dec. 2/6

Electrolytic Copper.

		£	s.	d.	
July	20 ..	41	10	0	No change
,,	21 ..	41	0	0	dec. 10/-
,,	24 ..	40	10	0	,, 10/-
,,	25 ..	41	0	0	inc. 10/-
,,	26 ..	41	0	0	No change

Standard Tin (cash).

		£	s.	d.	
July	20 ..	212	15	0	dec. 75/-
,,	21 ..	212	15	0	No change
,,	24 ..	213	2	6	inc. 7/6
,,	25 ..	215	15	0	,, 52/6
,,	26 ..	214	15	0	dec. 20/-

Tin (English ingots).

		£	s.	d.	
July	20 ..	213	5	0	dec. 75/-
,,	21 ..	213	5	0	No change
,,	24 ..	213	15	0	inc. 10/-
,,	25 ..	216	5	0	,, 50/-
,,	26 ..	215	10	0	dec. 15/-

Spelter (ordinary).

		£	s.	d.	
July	20 ..	17	16	3	dec. 6/3
,,	21 ..	17	12	6	,, 3/9
,,	24 ..	17	7	6	,, 5/-
,,	25 ..	17	15	0	inc. 7/6
,,	26 ..	17	7	6	dec. 7/6

Spelter (Electro, 99.9 per cent.).

		£	s.	d.	
July	20 ..	20	5	0	No change
,,	21 ..	20	0	0	dec. 5/-
,,	24 ..	19	15	0	,, 5/-
,,	25 ..	20	0	0	inc. 5/-
,,	26 ..	19	15	0	dec. 5/-

Zinc Sheets (English).

		£	s.	d.	
July	20 ..	26	0	0	No change
,,	21 ..	26	0	0	,, ,,
,,	24 ..	26	0	0	,, ,,
,,	25 ..	26	0	0	,, ,,
,,	26 ..	26	0	0	,, ,,

Lead (English).

		£	s.	d.	
July	20 ..	15	0	0	No change
,,	21 ..	14	15	0	dec. 5/-
,,	24 ..	14	10	0	,, 5/-
,,	25 ..	14	15	0	inc. 5/-
,,	26 ..	14	15	0	No change

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1893	36 0	34 8	34 4	34 2	33 10	34 8	35 3	35 5	35 4	34 8	34 7	35 9	34 10
1894	35 8	35 11	36 1	36 1	35 5	35 5	35 5	35 11	36 6	35 8	35 8	35 1	35 9
1895	34 7	34 4	34 4	34 8	35 6	35 2	36 1	37 1	38 10	38 6	37 11	37 6	36 3
1896	37 3	38 4	38 7	38 1	37 4	37 4	36 11	36 11	37 11	39 2	40 5	40 5	38 3
1897	41 2	40 4	40 5	39 2	39 7	40 9	39 6	40 5	41 7	42 5	41 5	40 4	40 7
1898	40 9	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 0
1899	46 10	47 11	47 9	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	43 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 0	42 10	42 9	43 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	62 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48 1	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	46 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 5½
1913	66 11½	65 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	65 7
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	85 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	99 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	136 0	128 1½	121 11	97 1½	97 0	100 0	100 0	110 6½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	81 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 0	86 3
1927	85 0	83 1½	81 0	80 0	78 9	70 0	70 0	68 9	67 6	67 6	66 10½	65 0	73 2½
1928	65 0	65 0	65 6	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	65 9½
1929	66 0	66 9	67 0	68 1½	69 5	71 10½	72 9	72 6	72 6	72 6	72 6	72 6	70 4½
1930	72 6	72 6	70 0	67 6	67 6	67 6	67 6	64 6	63 6	63 6	63 6	63 6	66 11½
1931	59 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 7
1932	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6
1933*	62 6	62 6	62 6	62 6	62 6	62 6	62 6	—	—	—	—	—	—

* Delivered Middlesbrough area. Prior to 1933, prices were f.o.t. furnaces.

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